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REPORT NO. 1115
MARCH 1961

A THIRD SURVEY OF DOMESTIC ELECTRONIC DIGITAL COMPUTING SYSTEMS

Martin H. Weik

This report supersedes BRL Report No. 1010

Department of the Army Project No. 5B03-06-002
Ordnance Management Structure Code No. 5010.11.812

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REPORT NO. 1115

MWeik/vjc
Aberdeen Proving Ground, Md.
March 1961

A THIRD SURVEY OF DOMESTIC ELECTRONIC DIGITAL COMPUTING SYSTEMS

ABSTRACT

Based on the results of a third survey, the engineering and programming characteristics of two hundred twenty-two different electronic digital computing systems are given. The data are presented from the point of view of application, numerical and arithmetic characteristics, input, output and storage systems, construction and checking features, power, space, weight, and site preparation and personnel requirements, production records, cost and rental rates, sale and lease policy, reliability, operating experience, and time availability, engineering modifications and improvements and other related topics. An analysis of the survey data, fifteen comparative tables, a discussion of trends, a revised bibliography, and a complete glossary of computer engineering and programming terminology are included.

This report supersedes BRL Report No. 1010 (Public Bulletin [illegible]5R, OTS, U. S. Department of Commerce).

ACKNOWLEDGMENT

On behalf of the Computing Laboratory of the Ballistic Research Laboratories, the author wishes to extend his appreciation for the excellent spirit of cooperation displayed by the various representatives of government and industry who have devoted their time and effort in responding to the survey inquiries.

Many valuable suggestions were received from the engineering and mathematical staff personnel of the Computing Laboratory of the Ballistic Research Laboratories.

The Data Systems Research Staff, Office of the Assistant Secretary of Defense, Comptroller, devoted much effort during the conduct of the survey, particularly as pertains to coordination within the Armed Services. It is the expressed intent of the Office of the Assistant Secretary of Defense, Comptroller, to reprint this report at the Government Printing Office, Washington, D. C., for sale and distribution to the public.

The greatest individual assistance was rendered by WAC Staff Sergeant Violet J. Confer. An undertaking as comprehensive as this national survey, requires that a large quantity of data be acquired, correlated, transcribed and checked. Particular attention must be paid to accuracy and detail. We are heavily indebted to Staff Sergeant Confer for the major role she has performed in all phases of preparation of this report. She has been responsible for the general conduct of the survey, the control of communications with respondents, the preparation of correspondence, screening returns, sorting returns, preparing the layout of all pages, and doing all the art work, typing, titles, and photo arrangements.

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CHAPTER I

INTRODUCTION

INTRODUCTION

PURPOSE OF THE SURVEY REPORT

Before any major decision can be made regarding the acquisition, installation, operation, improvement or retirement of computing equipment, first hand technical information must be obtained concerning the characteristics, availability, cost, operational problems, capability and useful life of available systems. Efficient management requires that the experience of others be exploited wherever such exploitation is beneficial. The present trend in the rapidly changing computing and data processing hardware field is toward higher operational speeds, increased memory capacity and reliability, and solid state electrical components, including a widespread use of semi-conductors and the advent of the use of thin magnetic films in standard commercial systems. However, only existing or readily available equipment may be utilized for the immediate solution of scientific and commercial data processing problems.

Many persons in the computing and data processing field continually seek answers to many different questions simultaneously. Some of these questions are: Can present methods, practices and procedures used in a given organization be accomplished by automatic computing and data processing equipment? Will investment in such equipment reduce costs, provide improved service, conserve manpower or save time? When shall existing computing equipment be modified, supplemented or replaced? Of all available equipment, what type of system is best suited for the solution of a given problem or a given group of problems? Is the maximum possible return being obtained from a given investment in computing equipment? Does a given problem require specially built equipment or is a solution to be found with commercially available standard equipment? Should computing equipment be rented or purchased? Should a system be installed "on the premises" or should computer time be purchased elsewhere? The purpose of a surveillance and evaluation program is to provide answers to these and similar questions.

Government agencies, particularly Department of Defense agencies, and their contractors, require the latest technical information concerning computing and data processing equipment in order to properly establish their policy regarding acquisition, installation, operation, improvement and retirement of equipment. The purpose, therefore, of this survey report is to allow government agencies and their contractors to benefit from the results of the computing system surveillance and evaluation program conducted by the Ballistic Research Laboratories.

In 1955, a survey of electronic digital computing systems was conducted by the Ballistic Research Laboratories in order to provide technical data for the evaluation of the then existing computing machine complement of the Laboratories. The results of that survey were made available in BRL Report Number 971, M. Weik "A Survey of Domestic Electronic Digital Computing Systems". The report was well received by persons in government and industry. The U. S. Department of Commerce undertook further printing and distribution of the report under cover of Public Bulletin 111996, Office of Technical Services.

A new survey of electronic digital computing systems was conducted during October, November and December 1956 and January 1957 by the Computing Laboratory of the Ballistic Research Laboratories. The new survey was conducted as part of the continuous surveillance and evaluation program of the Laboratory. The results were published as BRL Report Number 1010, June 1957. This report covered the results of the new survey and superseded BRL Report 971. The U. S. Department of Commerce undertook further printing and distribution of this report also, under cover of Public Bulletin 111996R, Office of Technical Services.

Due to the great interest which has developed in these survey reports, the Department of Defense has co-ordinated this activity among the Armed Services. This report contains the results of a third survey of domestic electronic digital computing systems.

SCOPE OF THE SURVEY REPORT

This report is limited to commercially available and existing operational electronic digital computing and data processing systems manufactured or operated within the United States. Large, intermediate and small scale systems are included, regardless of whether the determination of "scale" is based on size, weight, cost, storage capacity or any reasonable criterion. An attempt has been made to include both general purpose and special purpose equipment. It must be borne in mind that there is no clear-cut line of demarcation between systems designated as special purpose computing machines and certain "on-line" control applications, in which a computer is used to determine operational control-commands, based upon data received by the system from instruments measuring the results of the commands. These systems usually have analog input and output with internal digital computation and transformation of information to and from digital form.

Among the items not covered by this report are analog computing systems, foreign systems or separate computing system components, such as analog-digital converters, separate storage units, arithmetic units, input-output units, and data recording units, except when these are associated with specific complete systems. Many recording media converters, such as magnetic tape-to-card converters, card-to-paper tape converters, etc., are not specifically covered, except again as they are used with specific complete systems. By a "complete system" is meant an electronic digital computing system with input, output, control, arithmetic and/or logical and storage units.

PROCESSING OF THE SURVEY DATA

A consolidated system description was prepared from data made available by the user and the manufacturer. Information concerning each computing system was divided into the following sub-headings:

Applications
Programming and Numerical System
Arithmetic Unit
Storage
Input
Output
Circuit Elements of Entire System
Checking Features
Power, Space, Weight and Site Preparation
Production Record
Cost, Price and Rental Rates
Personnel Requirements
Reliability, Operating Experience and Time Availability
Additional Features and Remarks
Future Plans
Installations

The large volume of technical data processed for this report will make errors unavoidable, particularly in correlating and transcribing information. It will be appreciated if errors are brought to the attention of the Ballistic Research Laboratories. Statements, claims and criticisms were screened as much as possible. Every endeavor was made to insure that the information included in this report is factual. To a large extent certain superlative adjectives used in describing equipment, were deliberately eliminated as a matter of fairness and in order to avoid implication in sales activities.

INTERPRETATION OF THE SURVEY DATA

The interpretation of the data included in this report is perhaps the most difficult aspect of all, therefore much of this activity is left to the reader. In Chapter II, the data are grouped under alphabetically sequenced computing systems descriptions. The charts and tables in Chapter III have been prepared in order to show various relative characteristics, features and trends. A brief analysis and interpretation of the data accompanies these tables. It must be emphasized again that data concerning computing systems taken out of context or disassociated from other related data, can be misleading. Because of this, the information contained in this report, particularly the tabular data of Chapter III, must be used with appropriate caution.

It is recommended that the prepared tables in Chapter III be used only as generalizations to show trends. Data on specific systems should be taken from the systems descriptions rather than from the prepared tables. Further details must be obtained from manufacturers or users directly. This report does not constitute an indorsement of any of the products described within it.

USE OF THE SURVEY REPORT

As has been previously stated, the computing field is a dynamic and rapidly changing one. From a technological point of view, some of the information contained in this report is obsolete. Certain computing systems may be considered obsolete when they are installed. However, in most cases, manufacturers are accepting orders and will continue to produce, the systems described in this report for quite a number of years. Chapter II contains engineering and programming descriptions of 222 different types of computing systems. Persons who are interested in the acquisition of systems will find useful information on applications, cost, personnel requirements, and power and space requirements for specific systems. Operators may find useful suggestions on modifications and improvements. The question of reliability, a particularly difficult one to resolve, has been answered to some extent under the sub-heading: Reliability, Operating Experience and Time Availability. Under each sub-heading, the source of information is given. When a source is not stated, the manufacturer is the source of data.

A List of References and a revised Glossary are given in Chapters IV and V.

It is hoped that enough general and specific technical data have been compiled in the following four chapters to permit anyone involved in the computing and data processing field to draw at least some general conclusions and find answers to the questions which may be occupying his mind at the present time.

Martin H. Weik Jr.

MARTIN H. WEIK JR.

CHAPTER II

COMPUTING SYSTEMS DESCRIPTIONS

AF CRC

Air Force Cambridge Research Center Magnetic Computer

MANUFACTURER

Remington Rand Univac
Division of Sperry Rand Corporation

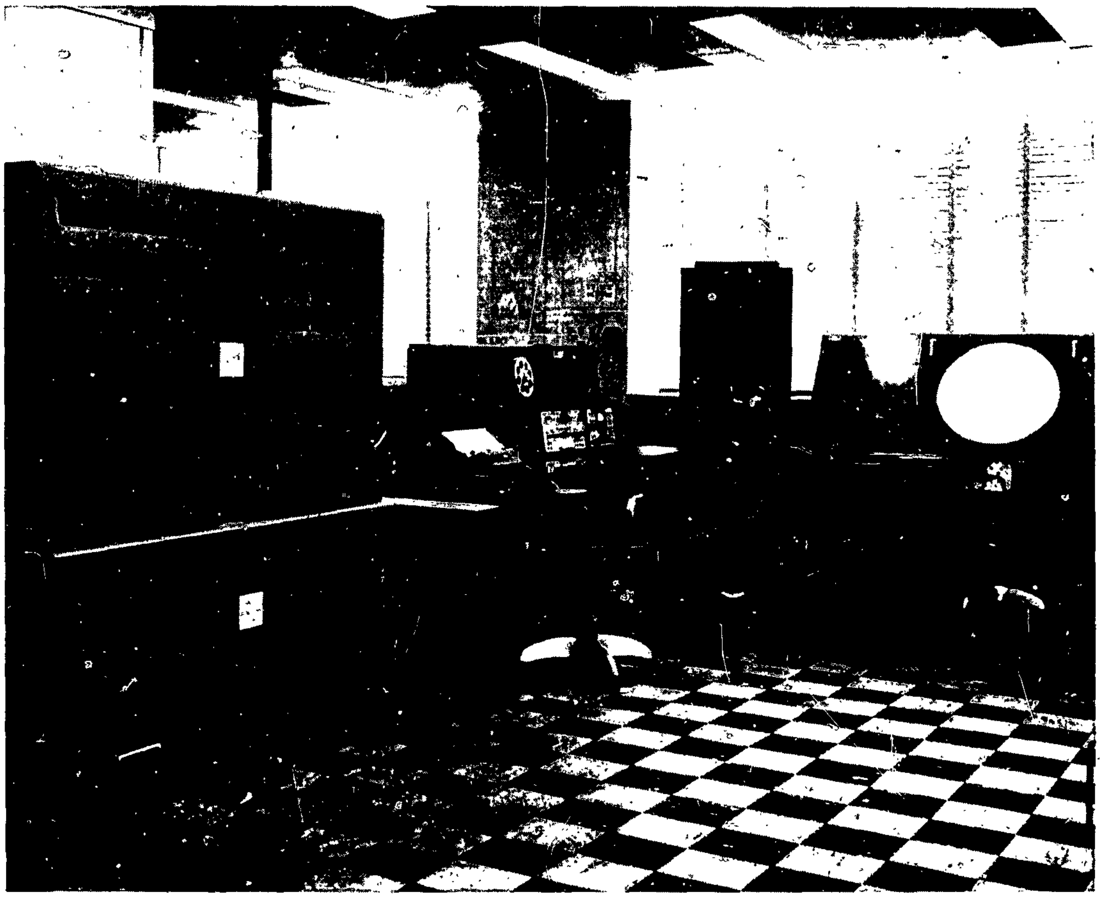


Photo by Air Force Cambridge Research Center

APPLICATIONS

Air Force Cambridge Research Center
Located at AFCRC, Hanscom Field, Mass., the system is used for general purpose scientific computations and as a flexible buffer for transfering data to paper tape.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	10 plus sign
Arithmetic system	Fixed point

ARITHMETIC UNIT

Operation	Incl Stor Access
Time	Microsec
Add	90
Mult	300 to 1,700
Arithmetic mode	Serial by dec dig within word Parallel by bit within dec dig
Pulse repitition rate	660 kilocycles/sec
Timing	Synchronous
Operation	Sequential

STORAGE

22,000 decimal digits (2,000 words, each ten digits plus sign). Aluminum drum, plated with nickel-cobalt alloy, spins at 16,500 rpm. Average access time 1.8 milliseconds. Four hundred of the 2,000 words are stored in fast-access bands with average access time of 450 microseconds. Active drum surface is 5 in. in diameter and 3 in. long.

INPUT

AFCRC

Media	Speed	
Paper Tape	180 char/sec	Alphanumeric
Typewriter	10 char/sec	Alphanumeric
Real-time Input	8,000 bits/sec	

OUTPUT

AFCRC

Media	Speed	
Paper Tape	180 char/sec	Alphanumeric
Typewriter	10 char/sec	Alphanumeric
Color Scope	7,700 points/sec	
Can be plotted in 3 colors		
Real-time Output	154,000 bits/sec	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Six hundred miniaturized circuit packages
Magnetic core Ferractors, developed by Sperry-Rand, are used as the basic logical control element for switching and amplifying.
15 Vacuum tubes are used.
All processing and control circuitry is mounted in one cabinet. Primarily solid state design.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

AFCRC

Power, computer	15 KVA, 3 phase, 208 volt, 60 cps
Volume, computer	140 cu ft
Area, computer	500 sq ft
Room size, computer	20 ft x 30 ft x 8 ft
Weight, computer	4,000 lbs

Computer unit is 6 ft high, 6 ft 6 in long and 1 ft 6 in deep. Console is 4 ft 6 in high, 6 ft long, and 3 ft deep. Cooling is by integral fan.

COST, PRICE AND RENTAL RATES

AFCRC

Cost of system is $800,000, including development costs. Development by Remington Rand Univac was sponsored by the Air Force Cambridge Research Center.

Maintenance/service contracting costs are $21,000 per man per year.

PERSONNEL REQUIREMENTS

AFCRC

	Three 8-Hour Shifts Used	Recommended
Supervisors	1	1
Analysts	4	4
Programmers	4	4
Operators	2	3
Engineers	1	1
Technicians	1	3

Operation tends toward open shop.
Method of training used is by apprenticeship.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

AFCRC

Average error-free running period 30 Hours
Good time 126 Hours/Week (Average)
Attempted to run time 140 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 1 Apr 59 to 1 Apr 60
Passed Customer Acceptance Test Apr 56
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

AFCRC

Outstanding feature is its solid state magnetic circuitry with a unique system of logic.

The color scope, the high-speed paper tape punch, and the circuitry for alphanumerics were added to the computer by AFCRC personnel.

FUTURE PLANS

AFCRC

The addition of a core memory of 4,096 words is anticipated. It is expected that this will speed up average computing time by a factor of 5 over minimum latency programming on the drum.

It is planned to improve the paper tape handling capability of the computer by installing newer paper tape readers and punches.

It is planned to expand the input-output capability by installing high-speed magnetic tape units.

INSTALLATIONS

U. S. Air Force
Cambridge Research Center ARDC
Laurence G. Hanscom Field
Bedford, Massachusetts

ALWAC II

Alwac (Axel-Wenner-Gren) Computer Model II

MANUFACTURER

Alwac Computer Division
El-Tronics, Inc.
-Formerly Logistics Research, Inc.

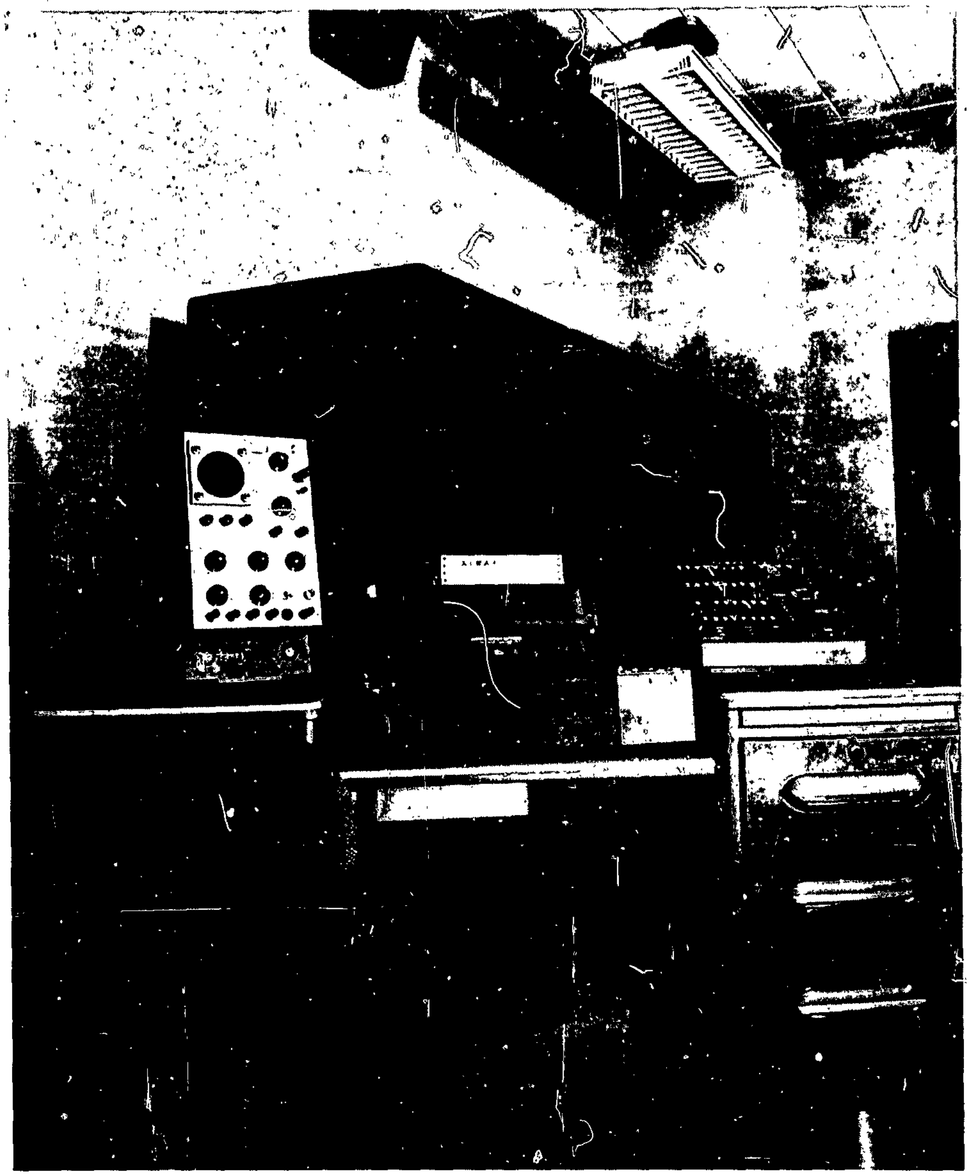


Photo by U. S. Navy David Taylor Model Basin

APPLICATIONS

Located at the Aerodynamics Laboratory, Transonic Building, the system is used for wind tunnel data reduction and computation and for solving engineering and scientific problems.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	32 plus sign
Binary digits/instruction	16 or 8, depending on instruction
Instructions per word	0,1,2,3 or 4, depending on order and address combination

Arithmetic system	Fixed point	

Floating point can be programmed.

Instruction type	One address

Some orders do not require an address, but it is basically one address system. An instruction consists of an order and an address (16 binary digits) or an order (8 binary digits). Since this computer follows orders from the first syllable (4 per word) of each of 8 words before following orders from the second syllable, each word could have 4 addresses, 1 order and 3 addresses, 2 and 2, 3 and 1 or 4 orders.

Number range 0 to $\pm 2^{32} - 1$

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	1,000
Mult	32,000
Div	32,000

Construction (Arithmetic unit only)
Vacuum tubes and diodes

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Input device is parallel.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	2,048	32 bits & sign	
Magnetic Drum (Fast Access)	64	32 bits & sign	8,000

Information must be copied into fast access in blocks of 32 words.

INPUT

Media	Speed
Flexowriter Keyboard	10 char/sec (alpha-numeric)
Flexowriter Paper Tape	10 char/sec (alpha-numeric)

OUTPUT

Media	Speed
Flexowriter Keyboard	10 char/sec (alpha-numeric)
Flexowriter Punch	10 char/sec (alpha-numeric)

Computer has programmed format controls.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

	Quantity
Tubes	250
Crystal diodes	3,500
Tube types	5963, 5687, 12AT7 (excluding power supply)

There are 13 different types of plug-in units.

CHECKING FEATURES

Checking features include memory verification, overflow, impossible order code, and automatic sequencing.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	4 Kw
Power, air conditioner	6 Kw
Volume, computer	158 cu ft (incl console)
Volume, air conditioner	44 cu ft
Area, computer	35 sq ft (incl console)
Area, air conditioner	7 sq ft
Room size, computer	240 sq ft
Floor loading	93 lbs/sq ft 900 lbs concen max
Capacity, air conditioner	5 Tons
Weight, computer	2,100 lbs
Weight, air conditioner	1,000 lbs

Power is 115 V, 60 cycles, single phase. Air conditioner depends on room size and cooling. The 5 Ton air conditioner is used for 2 computers in one room. Area and volume figures include the console, but weights do not.

PRODUCTION RECORD

Number produced to date 2
No longer in current production. Model II has been superseded by the III E. (See ALWAC III E).

COST, PRICE AND RENTAL RATES

System cost approximately $50,000.
Maintenance is performed by our own electronic engineer.

PERSONNEL REQUIREMENTS

This is an old computer, still operable with nominal maintenance required. It is not used in regular production, but for miscellaneous engineering problems where its speed is relatively unimportant.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	43 Hours
Good time	3,250 Hours
Attempted to run time	4,065 Hours
Operating ratio (Good/Attempted to run time)	0.80
Above figures based on period	7 Jun 54 to 16 Oct 56
Passed Customer Acceptance Test	7 Jun 54

ADDITIONAL FEATURES AND REMARKS

System advantages are order address is automatic, has a decision register, low cost, and ease of maintenance. This machine is no longer in production in favor of an improved model.

INSTALLATIONS

U. S. Navy
Bureau of Ships
David Taylor Model Basin
Washington 7, D. C.

ALWAC III E

Axel Wenner Gren Automatic Computer III E

MANUFACTURER

Alwac Computer Division
El-Tronics, Incorporated

Photo by Alwac Computer Division of El-Tronics, Inc.

APPLICATIONS

Manufacturer
System is used for computer simulation, photogrammetry analysis, on-line engine test data acquisition and reduction, automatic numerical machine tool control, linear programming and general purpose computing.

The Adjutant General, U.S.A.
System is used for analytical statistics such as correlation matrices, matrix algebra, test scoring, item analysis, test selection, and factor analysis.

David Taylor Model Basin
System is used for wind tunnel data reduction and computation, solving engineering and scientific problems, and for the solution of general engineering problems.

Offutt AFB, Nebraska
System is used for Geodesy, i.e. datum conversions, coordinate transformations, range and azimuths, and geodetic position computations; for photogrammetry, i.e. analytical triangulation, photo orientation and rectification; for intelligence reduction; and for library retrieval.

Aeronautical Structures Laboratory
High temperature, structural, fatigue, and loads research projects. Data reduction on check-out, preliminary, and final test. Results are presented in a form to be tabulated on a 402 and plotted on electroplotters. The answer cards contain fixed information, answers and series of "x" punches to control printing in any of 14 columns. Thus, the results of a test are available in tabular form suitable for inclusion in reports.

Statistical data from fleet flight-maneuver and aircraft landing-loads programs. Motion pictures are made of the airplane approach and landing aboard an aircraft carrier. After the film is analyzed and transcribed on the film-reading system to IBM cards, a versatile computer program fits by a least-square-curve fitting method a polynomial space-time-curve to the airplane motion. Numerical differentiation of this curve is used to obtain velocity and acceleration at different points in the flight path. Altogether 22 landing parameters are obtained from each landing. A further statistical analysis of the parameters is performed to determine probability curves, deviation, skewness, variance, confidence limits and other statistical relationships. For the flight-loads program, information concerning the use of naval airplanes is obtained from flight recorders which make a permanent record of the most important things that happen, structure-wise, to the airplane while it is happening. From this data, airspeed, altitude, Mach number, 3 "G" load factors and 3 accelerations are computed.

Study of structural problems associated with space vehicles. Solution on the computer of nonlinear differential equation with variable coefficients by numerical methods of approximating the required solution.

Bulova Research & Development Laboratories, Inc.
System is used for the numerical solution of systems of ordinary differential equations, optical ray tracing, parameter variation studies, reduction of test data, e.g. curve fitting and auto correlation, spectrum analysis, and probability distribution analysis.

Institute of Gas Technology
System is used for the calculation of mass spectrometer data, gas distribution network analysis, chemical equilibrium studies, and correlation problems involving gas send-out and weather data.

Reliance Electric & Engineering Company
System is used for the design of electric machinery, and associated problems.

Southwestern Computing Service, Inc.
System is used for process equipment design, geophysical data reduction, and miscellaneous research problems.

Photo by U. S. Army - TAGO

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	32 + sign
Binary digits/instruction	16
Instructions per word	2, 3 or 4
Instructions decoded	101 Basic (Many are micro-programmable)
Arithmetic system	Fixed point

Commands normally consider numbers to be integral

Instruction type	One address

Optimum sequencing is built in

Number range	64 bits

Negative numbers are indicated by sign

Decimal input and output are built-in with a single command capable of taking in up to 8 digits.

Several systems are available both for floating point or fixed point operations.

Neumonic interpretive routines as well as symbolic compilers are in use.

There are four registers, viz, a main accumulator 32 bits + sign + recoverable overflow bit, a secondary accumulator 32 bits + sign, an auxiliary register 32 bits + sign, and a 16 bit B-Box Index register.

The first two registers are combined for double precision operations. Also, complete shiftability applies to main accumulator as well as double length accumulator. Auxiliary register is used in multiplication, division, for special floating point assistance commands and masking operations.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	1,000	1,000
Mult	17,000	17,000
Div	17,000	17,000

Construction (Arithmetic unit only)

Vacuum-tubes	132
Diodes	5,000
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Two commands at once are picked off the drum and unless the first command of the pair is an executed jump instruction, a second access to the drum is not required as the next command is held ready for immediate use in a static register.

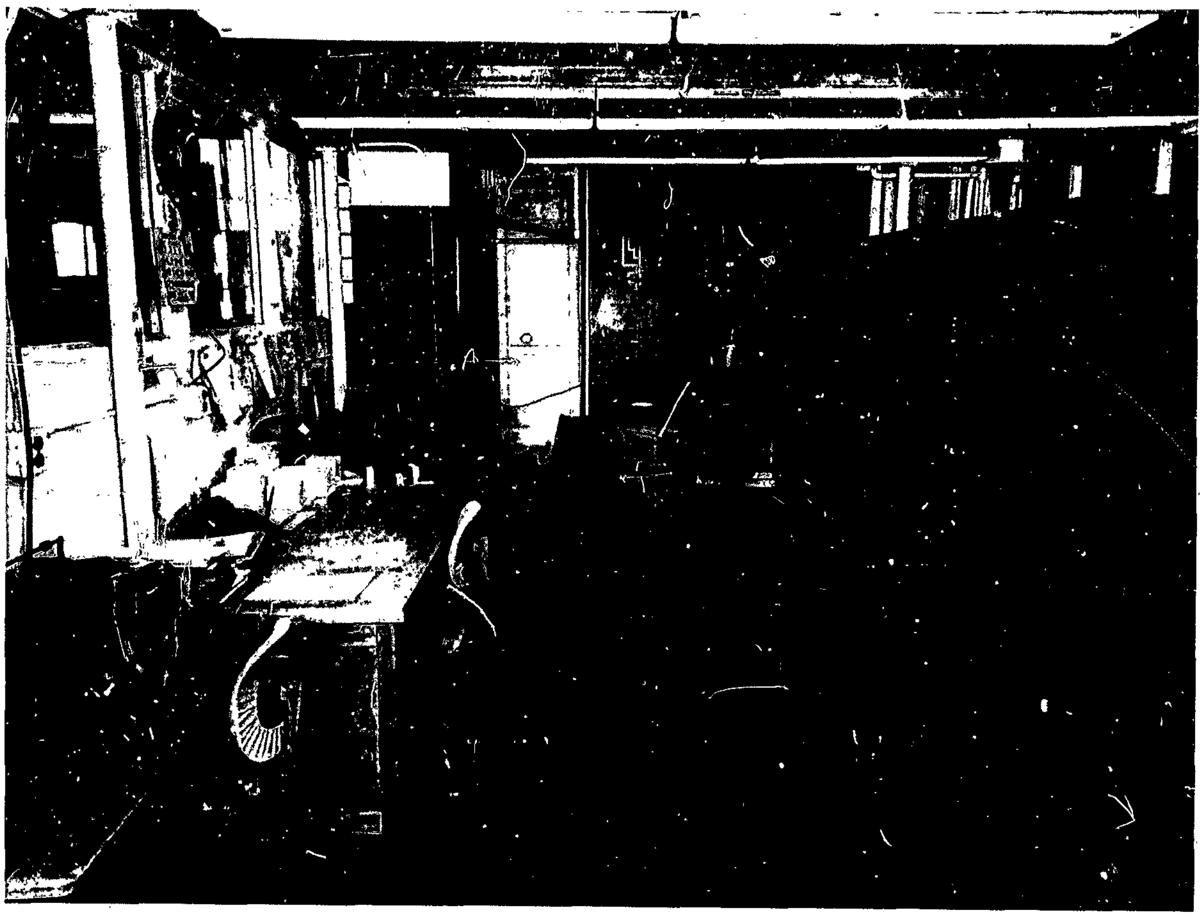


Photo by U. S. Navy - Bureau of Ships

STORAGE

Manufacturer

Media	No. of Words	Access Microsec
Drum	128	0 to 8,000
Drum	8,192	0 to 16,000
Core	32	500

Magnetic Tape

No. of units that can be connected	16	Units
No. of chars/linear inch of tape	155	Chars/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating each record	0.25	Inches
Tape speed	120	Inches/sec
Transfer rate	20,800	Chars/sec
Start time	9	Millisec
Stop time	7	Millisec
Average time for experienced operator to change reel of tape	60	Seconds
Physical properties of tape		
Width	1/2	Inches
Length of reel	2,400	Feet
Composition	Sandwich Mylar	

Each tape transport has its own search register. Once directed to search for data, the transport is independent of the computer and tape buffer. The tape buffer is a 32-word core storage unit which works between the computer and up to 16 magnetic tape handlers. Individual words within the core buffer are addressable and useable by the computer.

INPUT

Manufacturer

Media	Speed
Paper Tape (Flexowriter)	Manual or 10 char/sec
Paper Tape (High-Speed)	180 char/sec
80-Column Cards	100 cards/min
Curve Follower	20 points/sec

Special tie-ins have been made to analog to digital conversion equipment. Speed of entry possible depends upon number system and format arrangement.

Aeronautical Structures Laboratory

Data is prepared for the computer off-line on the following: Five oscillogram reading systems, three film reading systems. Input and output cards are checked for double punch and blank-column on an IBM 101 statistical machine.

Photo by U. S. Air Force - Offutt AFB

OUTPUT

Manufacturer	Speed
Paper Tape (Flexowriter)	10 char/sec
Paper Tape (High-Speed)	60 char/sec
80-Column Cards	100 cards/min
Line Printer	150 lines/min
Magnetic Tape	21,000 char/sec
Plotter	20 points/sec

The line printer used is an IBM type 407. It is completely useable as a standard off-line unit with only a change of plug board.

Aeronautical Structures Laboratory

Off-line the data is tabulated on an IBM 402 alphabetical accounting machine (series 50) or plotted on the two electroplotters which operate at 25 cards/minute.

Institute of Gas Technology

A Western Electric paper tape punch at 50 char/sec is connected to the computer through a buffer.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity	Remarks
Tubes	780	319 in basic system
Diodes	13,500	5,870 in basic system 7,630 in additional equipment
Transistors	75	66 tape transport 9 tape buffer
Magnetic Cores	1,280	

The basic system includes the Power Supply, Memory Unit, and Logic Unit.

Additional Equipment includes the Standard Card Converter, Magnetic Tape Buffer, Magnetic Tape Transport, and the High Speed Paper Tape Console.

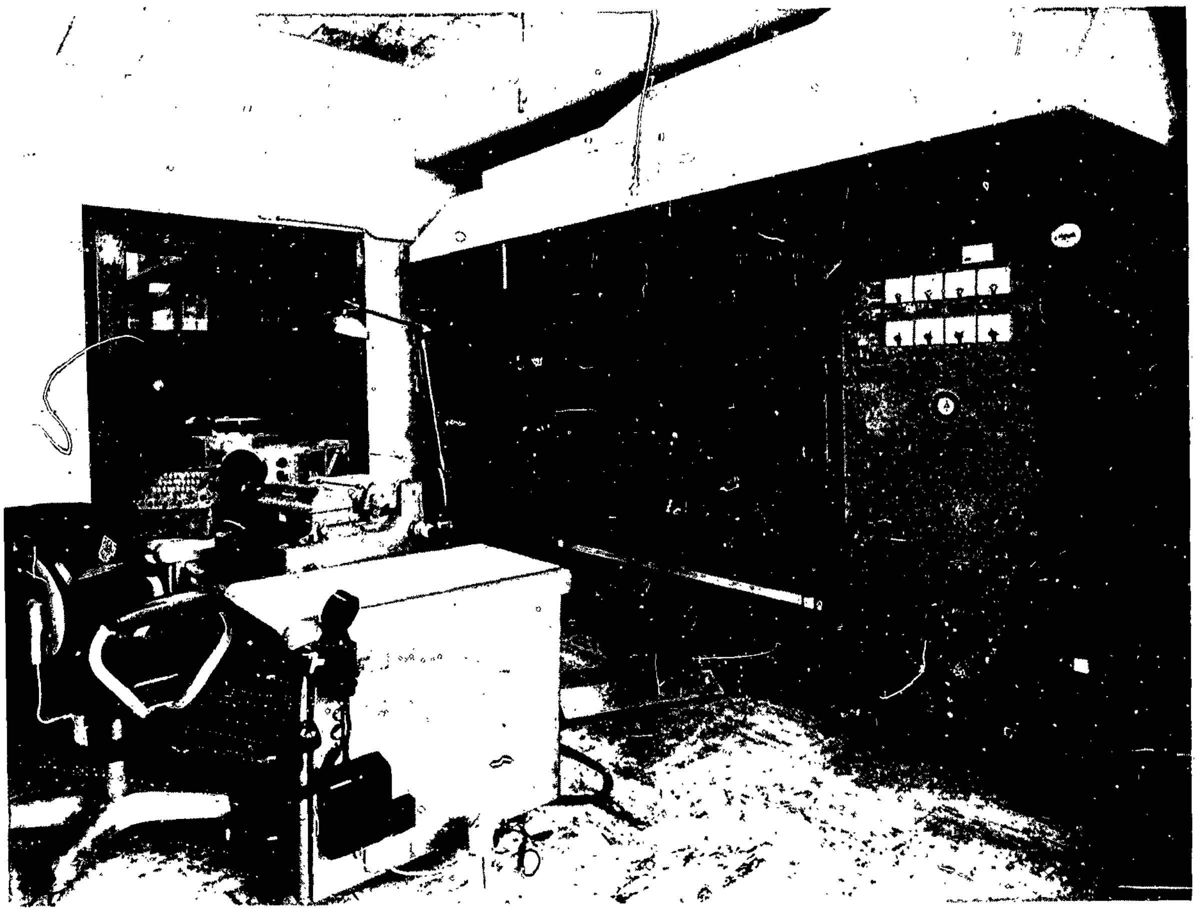


Photo by Bulova Research and Development Laboratories

CHECKING FEATURES

Manufacturer

An arithmetic operation overflow alarm is built on. A switch-controlled bit by bit comparison of all data transferred between high-speed loops and main memory can be made.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	5 Kw	0.9 - 1.0 pf
Volume, computer	160 cu ft	
Area, computer	30 sq ft	
Room size, computer	16 ft x 19 ft	
Weight, computer	2,690 lbs	

Above requirements are for the basic system.

The ideal site requirements are cable troughs, an acoustic ceiling, 75°F room ambient temperature, 4 ft. clearance around computer, a maintenance bench with 2 electrical outlets, and a storage space for spare parts.

The Adjutant General, U.S.A.

Power, computer	13 Kw
Power, air conditioner	100 KVA
Volume, computer	277 cu ft
Volume, air conditioner	50 cu ft
Area, computer	52 sq ft
Area, air conditioner	8 sq ft in computer room
Room size, computer	500 sq ft
Room size, air conditioner	200 sq ft
Floor loading	91 lbs/sq ft 140 lbs concen max
Capacity, air condition	12 1/2 Tons
Weight, computer	4,800 lbs

Site preparation included air conditioning and power modifications.

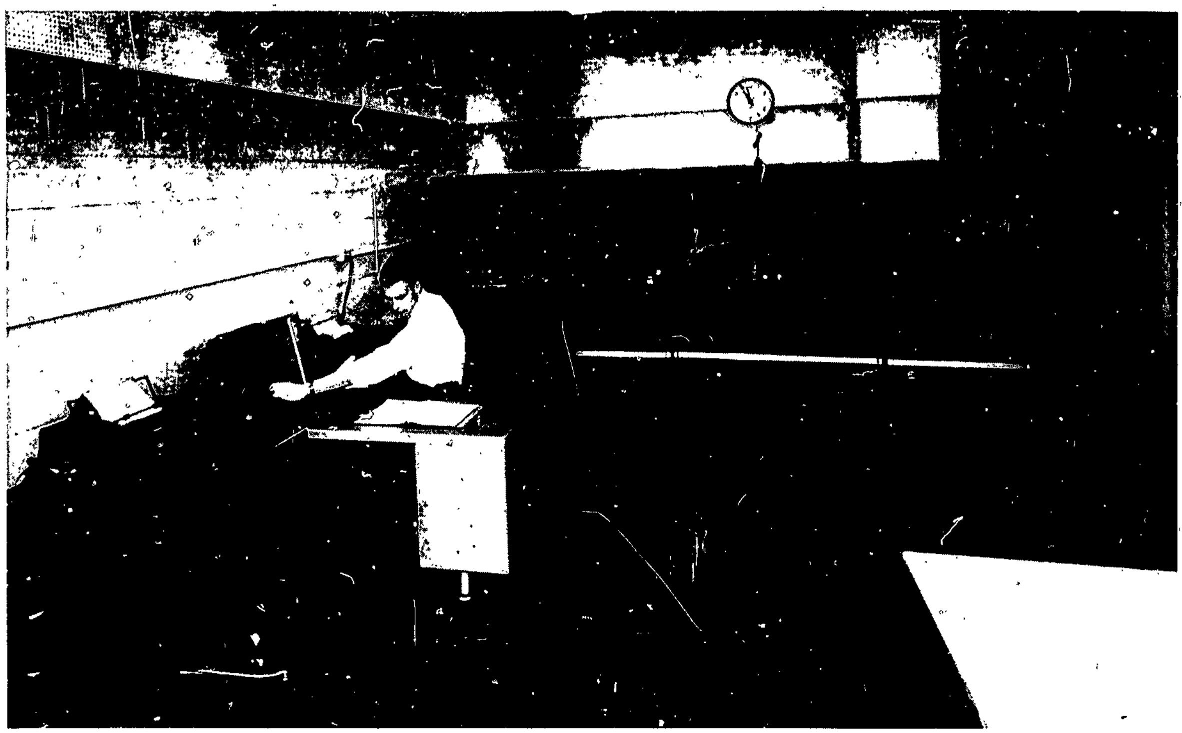


Photo by the Institute of Gas Technology

David Taylor Model Basin

Power, computer	6 Kw	220 V
Power, air conditioner	6 Kw	

Optional, depends on room size and cooling

Volume, computer	231 cu ft
Volume, air conditioner	44 cu ft
Area, computer	45 sq ft
Area, air conditioner	7 sq ft
Room size, computer	240 sq ft
Floor loading	80 lbs/sq ft
	900 lbs concen max
Capacity, air conditioner	5 Tons
Weight, computer	2,200 lbs
Weight, air conditioner	1,000 lbs

Area and volume include console and high speed reader but weights do not.

System uses 220 Volt, single phase, 60 cycles, 3 wire. Air conditioner is used for 2 computers in one room.

Offutt AFB, Nebraska

Power, computer	17.5 Kw	0.9 - 1.0 pf
Volume, computer	361 cu ft	
Area, computer	64 sq ft	
Room size	26 ft x 26 ft	
	676 sq ft	
Floor loading	88 lbs/sq ft	
	140 lbs concen max	
Weight, computer	5,630 lbs	

The building is air conditioned. An AC voltage regulator and adequate power outlets are required.

Aeronautical Structures Laboratory

Power, computer	10 Kw	15 KVA
Power, air conditioner	45 Kw	
Volume, computer,	234 cu ft	
Volume, air conditioner	64 cu ft	
Area, computer	47 sq ft	
Area, air conditioner	24 sq ft	
Room size, Computer	20 ft x 16 ft	
Room size, air conditioner	Suspended from ceiling	
Floor loading	100 lbs/sq ft	
Capacity, air conditioner	33 Tons	
Weight, computer	3,200 lbs	

Air conditioner includes peripheral equipment requirements.

The computer facility area 80 feet by 48 feet is partitioned into the following areas:

- Computer and off-line output equipment
- Data reduction (film)
- Data reduction (oscillographs)
- Equipment repair
- Office space

The following was installed: acoustic celotex ceiling, 230V, 100A, 3 phase, outlet for computer, comp. air (90 p.s.i.) with valves and hoses in each area, three power distribution panels 110V, 100A, 1 phase with extensive outlets for the peripheral equipment.

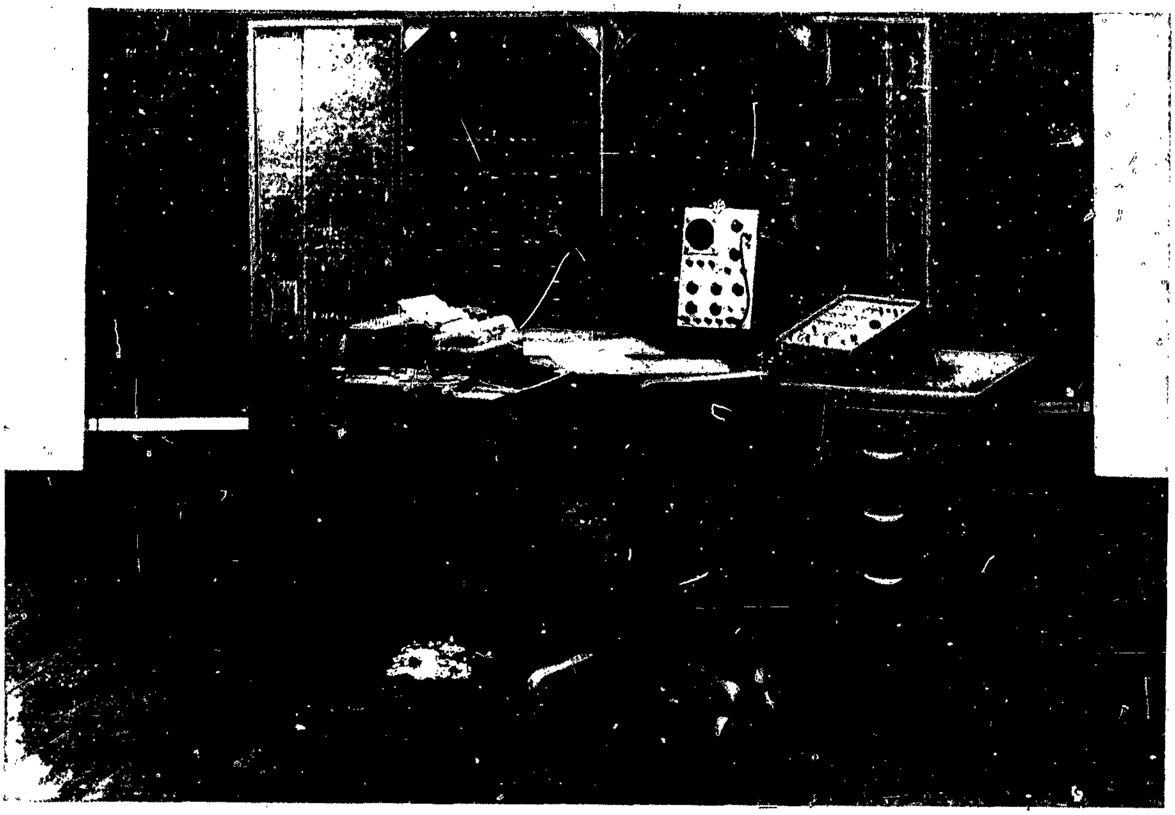


Photo by Logistics Research, Inc.

Bulova Research & Development Laboratories, Inc.

Power, computer	7.7 Kw
Volume, computer	185.35 cu ft
Area, computer	38.9 sq ft
Room size	18 ft x 18 ft x 11 ft
Weight, computer	2,864 lbs

Air conditioning is an estimated 5 Tons from central air conditioning system.

Site preparations included soundproofed room, additional air conditioning ducts, and an exhaust fan with hood.

Institute of Gas Technology

Power, computer	7 Kw
Volume, computer	248 cu ft
Volume, air conditioner	37 cu ft
Area, computer	45 sq ft
Area, air conditioner	5 1/4 sq ft
Room size, computer	18 ft x 24 ft
Room size, air conditioner	18 ft x 24 ft
Capacity, air conditioner	3 Tons
Weight, computer	2,500 lbs

Site preparation included a required 220V, 60 cycle, single phase, power line.

Reliance Electric & Engineering Company

Power, computer	7 Kw 7 KVA 0.97 pf
Volume, computer	4,000 cu ft
Area, computer	500 sq ft
Room size, computer	24 ft x 24 ft

Air conditioner is combined with other equipment. Room was designed for electronic tabulating equipment.

PRODUCTION RECORD

Manufacturer

Number in current production	3
Time required for delivery	1 Month

COST, PRICE AND RENTAL RATES

Manufacturer

Components of Basic System	Cost	Rental/ Monthly
Power Supply, Flexowriter, Monitor Scope, Control Console, Logic and Control Unit, Memory Unit	$76,950	$2,500
Additional Equipment		
High Speed Perforated Tape Console (Punch & Read)	10,950	290
Paper Tape Buffer	26,200	750
Card Converter	24,750	660
Magnetic Tape Buffer	21,000	580
Magnetic Tape Transport	23,100	640

Maintenance

Full-time resident engineer - $15,000 per year.
On-Call - $120/Day plus travel, not to exceed 500 miles.
Scheduled Service - 10% of list price of equipment per year.

The Adjutant General, U.S.A.

Computer (including console and Flexowriter), card converter, and magnetic tape buffer cost $105,000.

Rental rates for additional equipment is a card reader and punch at $140/month.

Maintenance, including parts is $12,000 per year.

David Taylor Model Basin

Cost is approximately $70,000.

High Speed Paper Tape Reader and Punch rents at $260/month.

Maintenance is done by our own electronic engineer.

Offutt AFB, Nebraska

The computer control and arithmetic unit cost $69,950, the modified Flexowriters (2) cost $4,950, and the high speed punch and tape cost $4,950. The card converter cost $22,500, the IBM 514 reproducing punch cost $5,700, the magnetic tape transports (2) cost $46,000, and the magnetic tape buffer cost $18,000.

Maintenance cost $15,000 per annum.

Aeronautical Structures Laboratory

Power supply, logic, magnetic drum, card converter cost $85,000.

Peripheral equipment - five oscillogram and three film reading systems and two electroplotters cost $169,000.

The IBM 514 input-output to computer rents at $1,320 per year.

IBM peripheral equipment-punches, verifier, sorter, statistical machine, reproducing punches, accounting machine, etc. rent at $20,000/year.

ASL does its own maintenance and servicing.

Bulova Research & Development Laboratories, Inc.

The Memory Cabinet (8,196 word drum), Flexowriter, Oscilloscope, Logic Cabinet, Power Supply Cabinet, Control Panel, and Memory Display rents at $2,350/month.

The High Speed Paper Tape, Reader, and Punch rents at $260/month.

Institute of Gas Technology

The basic computer, Flexowriter input and output cost $50,000. The High Speed Paper Tape Reader and Punch, with one word buffer cost $10,000.

Reliance Electric & Engineering Company

The Flexowriter and basic computer, with 4,096 word drum, cost $56,000.

The High Speed Console cost $18,000 and the 8,192 word drum (replacement) cost $12,000.

Maintenance cost $600/month.

Southwestern Computing Service, Inc.

System requires almost no maintenance. We do our own.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shift	Three 8-Hour Shift
Supervisors	1		
Coders	2		
Operators	1	2	3
Engineers	1	1	2

Training made available by the manufacturer to users includes free training in coding and operation at manufacturing plant. Training in maintenance is by special arrangement.

The Adjutant General, U.S.A.

	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recommended
Supervisors	1	1
Analysts	3	3
Programmers	3	4
Clerks		1/2
Librarians		1/2
Operators	2	2
Engineers	1	1

Specific to needs and problems encountered in this organization (other users may very well require more or fewer of each).

Operation tends toward closed shop.

David Taylor Model Basin

	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recommended
Supervisors	1	1
Programmers	2	3
Operators	3	3
Engineers (Maint.)	1	1

Operation tends toward closed shop.

Methods of training used includes informal instruction. Machine made available to engineers on open shop basis using Floating Point interpretive routines or compilers.

Offutt AFB, Nebraska

	One 8-Hour Shift Recommended	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recomm
Supervisors		2	2
Programmers		4	4
Engineers	1		

Operation tends toward open shop.

Methods of training used includes on-the-job training.

Aeronautical Structures Laboratory

	One 8-Hour Shift Used	One 8-Hour Shift Recomm	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recomm
Supervisors	2	2		
Programmers		2		
Clerks		1		
Operators	1	1		1
Engineers	1	2		
Technicians	4	4	1	1

Operation tends toward open shop fpr peripheral equipment and closed shop for computer. Some personnel have taken courses in advanced programming, numerical analysis and numerical solutions of differential equations. On-the-job training is used for the technicians and IBM training is used for peripheral IBM equipment.

Bulova Research & Development Laboratories, Inc.

	One 8-Hour Shift Used	One 8-Hour Shift Recommended
Supervisors	1	1
Analysts	2	2
Programmers	1	2
Operators		1
Engineers	1	1

Operation tends toward closed shop.

Methods of training used includes individual instrution on the job.

Institute of Gas Technology

	One 8-Hour Shift Used	One 8-Hour Shift Recommended
Supervisors	1	1
Programmers	1	2
Clerks	1	1
Technicians	1	1

Methods of training used includes on-the-job.

Reliance Electric & Engineering Company

	One 8-Hour Shift Used	Recommended
Supervisors	1/2	
Programmers	1	2
Operators	1	1

Operation tends toward closed shop.
Methods of training is mostly on individual basis.
Computer has made a major contribution to our engineering effort. Recognition of this fact is company-wide, and unchallenged.

Southwestern Computing Service, Inc.

	One 8-Hour Shift
Programmers	2
Operators	1

Operation tends towards closed shop.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Average user reliability figures are 96.4% useful computing time.

The Adjutant General, U.S.A.

Time is available for rent to qualified outside organizations.
The current model of the ALWAC III E (serial 28) was installed so recently that adequate data are not yet available.

David Taylor Model Basin

Good time 46 Hours/Week (Average)
Attempted to run time 52 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.884
Above figures based on period 1 May 59 to 30 Apr 60
Time is available for rent to qualified outside organizations.

Offutt AFB, Nebraska

Average error-free running period 20 Hours
Good time 75 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period Jul 59 to May 60
Time is not available for rent to outside organizations.

Aeronautical Structures Laboratory

Average error-free running period 100 Hours
Good time 72 Hours/Week (Average)
Attempted to run time 80 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period Nov 55 to Apr 60
Passed Customer Acceptance Test Nov 55
Time is available for rent to qualified outside organizations.

In May 1957, after 2,000 hours of good computing time, a card converter, larger memory and new power supply were installed. Since October 1958 the computer has been on a two-shift operation. A new drum was installed in October 1959. As of 1 May 1960, the computer has over 9,000 hours of good computing time.

Bulova Research & Development Laboratories, Inc.

Average error-free running period 2 Weeks
Good time 25 Hours/Week (Average)
Attempted to run time 27 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.926
Above figures based on period 22 Jan 59 to 16 Jun 60
Passed Customer Acceptance Test 22 Jan 59
Time is available for rent to outside organizations.

Above figures include scheduled maintenance. If this time is omitted, the figures are good time 25, attempted to run time 25.5, and operating ratio 0.98.

Institute of Gas Technology

Average error-free running period 80 hrs, approx.
Good time 35 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period from 55 to Present
Passed Customer Acceptance Test 1955
Time is available for rent to qualified outside organizations.

Our records are not set up to obtain the above data accurately.

Reliance Electric & Engineering Company

Good time 36 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period Feb 56 to Present
Passed Customer Acceptance Test Feb 56
Time is available for rent to qualified outside organizations.

Southwestern Computing Service, Inc.

Good time 40 Hours/Week (Average)
Attempted to run time 39 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.975
Above figures based on period from 56 to Present
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include a large internal memory, (Over 16,000 program step storage), built-in-to hardware decimal-binary conversion, a large command structure, fully alpha numeric notation and an index register.

Unique system advantages include automatic decimal-binary conversion on cards, tape transports with independent searchability, and as many as 4 commands per word.

Special recommended procedures for magnetic tape storing includes temperature at 60 - 85°F and humidity at 40% to 60%.

The Adjutant General, U.S.A.

This ALWAC III Ehas been modified to read binary which is quite desirable for the work here. The system, for the cost, is large, flexible, and highly useful. The first ALWAC at the Personnel Research Branch was installed in June 1958. Although it was a useful productive machine, the precent of up time was less than would be desirable. The replacement computer, a larger and improved model, has been installed too recently to evaluate. Up time is expected to be well above 80%.

David Taylor Model Basin

Large memory and powerful logic structure make this system powerful and easy to program. It has an "E" box, it can read any 6-level paper tape, and it has complete program control of input-output operations and format.

Offutt AFB, Nebraska

Outstanding features include hexadecimal numbering system. Tapes are stored in steel filing drawers. The temperature and himidity are controlled to prevent damage to the tapes while in storage.

Bulova Research & Development Laboratories, Inc.

Outstanding features include a large memory, the ability to pack instructions 2 - 4 instructions per word, and built-in decimal-binary conversion.

Due to its small amount of tubes, the ALWAC III E is extremely reliable and easy to maintain.

The ALWAC III E is a general purpose single-address,

serial binary computer. The computer has 86 instructions and one index register. Basic number system for input-output is hexadecimal, using the digits a, b, c, d, e, f, for 10, 11, 12, 13, 14 and 15, respectively, in addition to 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. Magnetic tape and punched card equipment is also available.

Institute of Gas Technology

Outstanding features include large memory, rapid input-output, and a large order list.

System advantages includes a single address system which allows two program steps per word.

Reliance Electric & Engineering Company

Outstanding features include a large memory, low cost, and great flexibility. The Flexowriter gives unlimited flexibility in using all kinds of easily prepared forms. The paper tape is convenient for filing and for transmission via Teledata over telephone lines. It is used this way. Low cost made it possible for engineering to get it for its own use without sharing time with others.

Southwestern Computing Service, Inc.

Outstanding feature is reliability.

FUTURE PLANS

Aeronautical Structures Laboratory

To prevent interruptions in data processing, expansion of the facility is planned in stages. The installation of a new computer (with magnetic tape and punched card capabilities) is planned at the same time as the installation of the laboratory's high-speed data-gathering equipment. In the second stage, the existing ALWAC III will be modernized to the equivalent of the ALWAC III-E so that programs and routines can be interchanged. As a final stage, magnetic-tape capabilities will be added to the modernized ALWAC III for further flexibility of operations.

Southwestern Computing Service, Inc.

A faster input from the paper tape reader will be built.

INSTALLATIONS

The Adjutant General, U.S.A.
2nd & T Streets, S. W.
Washington 25, D. C.

David Taylor Model Basin
Washington 7, D. C.

544th Reconnaissance Technical Group
Offutt Air Force Base, Nebraska

Aeronautical Structures Laboratory
Naval Air Material Center
Philadelphia 12, Pennsylvania

Bulova Research & Development Laboratories, Inc.
62 - 10 Woodside Avenue
Woodside 77, New York

Institute of Gas Technology
17 West 34th Street
Chicago 16, Illinois

Reliance Electric & Engineering Company
24701 Euclid Avenue
Cleveland 17, Ohio

Southwestern Computing Service, Inc.
910 S. Boston
Tulsa 19, Oklahoma

AMOS IV

BLOCK DIAGRAM WITH APPROACH VISIBILITY CONFIGURATION

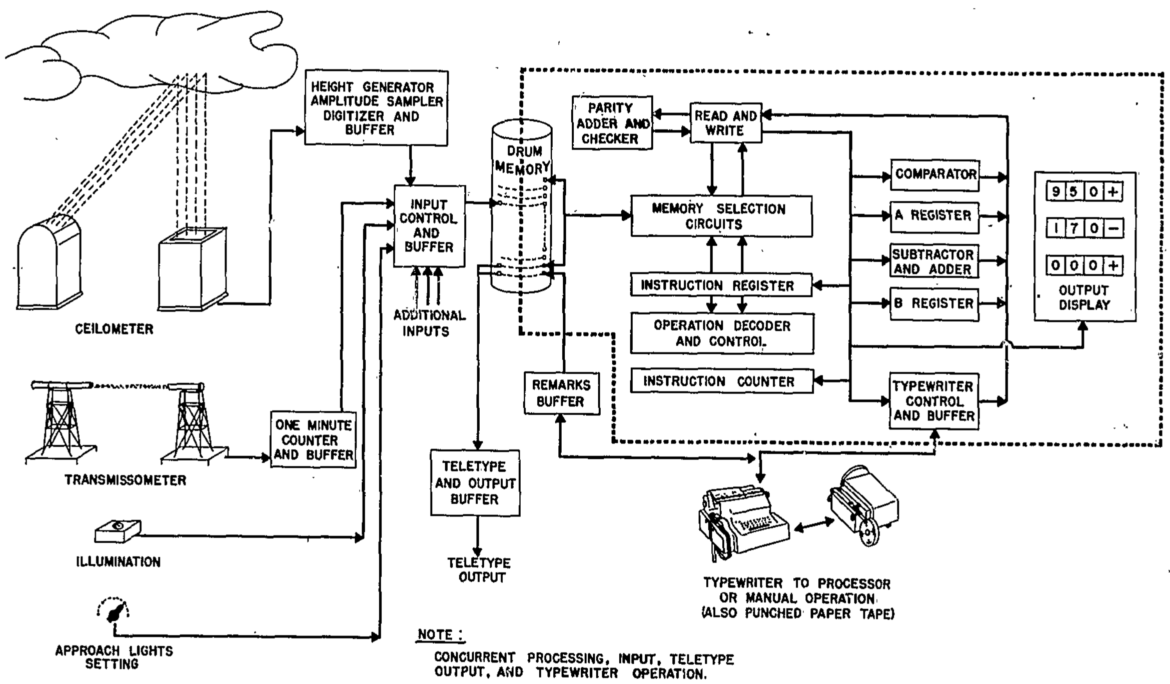


Chart by National Bureau of Standards

APPLICATIONS

The National Bureau of Standards in cooperation with the U. S. Weather Bureau has developed a specialized digital computer for the Weather Bureau to use as a research tool in exploring the concept of the automatic weather station. The AMOS IV Computer receives data from weather-sensing instruments and processes these data through such functions as sampling, comparing, selecting a maximum, and arithmetic operations. The results are transmitted via teletype to a central forecasting station and to other airport weather stations. Values of two quantities recently developed as aids to air safety - runway visual range and approach light contact height - are given by the machine through automatic table look-up.

For a number of years, the Weather Bureau has been appraising the possibilities of an automatic weather station. Such stations could be widely distributed, and would be especially useful in relatively inaccessible locations that are important sources of early data on meteorological activity. The various developmental prototypes of this concept have been called (Automatic Meteorological Observation Station); the current version, containing transistorized packages, is AMOS IV. It is an outgrowth of previous work done by NBS for the Weather Bureau that resulted in a special computer for processing cloud-height signals from a ceilometer. The ceilometer was intended for use with the AMOS III.

Several of the input quantities to the AMOS Computers, such as cloud height and precipitation, cannot be satisfactorily represented by instantaneous values but must be time-averaged. Varying amounts of data processing must therefore be associated with the different instruments measuring these quantities. In the AMOS III concept, several complex units were required for these functions. Although many of the functions were similar, the hardware was not minimized because of a diversity of design that resulted from the isolated development of the individual units. Analysis of the overall system indicated that a considerable reduction could be made in hardware and therefore in maintenance.

In AMOS IV, the automatic weather station is built around a single small, general-purpose computer designed especially for this application. The computer

Photo by National Bureau of Standards

receives data from the input instruments at any desired interval. These data are suitably processed and arranged in a specified order for teletype transmission in a variety of message formats and at various speeds. The computer also operates local and remote displays. Much latitude is available for research into the most desirable form of data processing because of the inherent flexibility of the internally programmed machine.

The machine must accomodate a number of input devices, all furnishing data continuously.

Extensive stored tables are needed for empirically determined data which varies from station to station.

A short word length is sufficient, since the data comes primarily from physical instruments; three digits and sign appear sufficient, relying on double-precision methods for those few cases where needed.

A comparatively slow circuit speed is acceptable, working in conjunction with the magnetic drum, which rotates at a moderate speed for long life and reduced cost.

The machine needs only a limited arithmetic capability, in view of the extensive stored tables; it can perform addition and subtraction, with other operations available through programming.

The machine must transmit teletypewriter messages at high and low speeds, independently of each other and of the data processor.

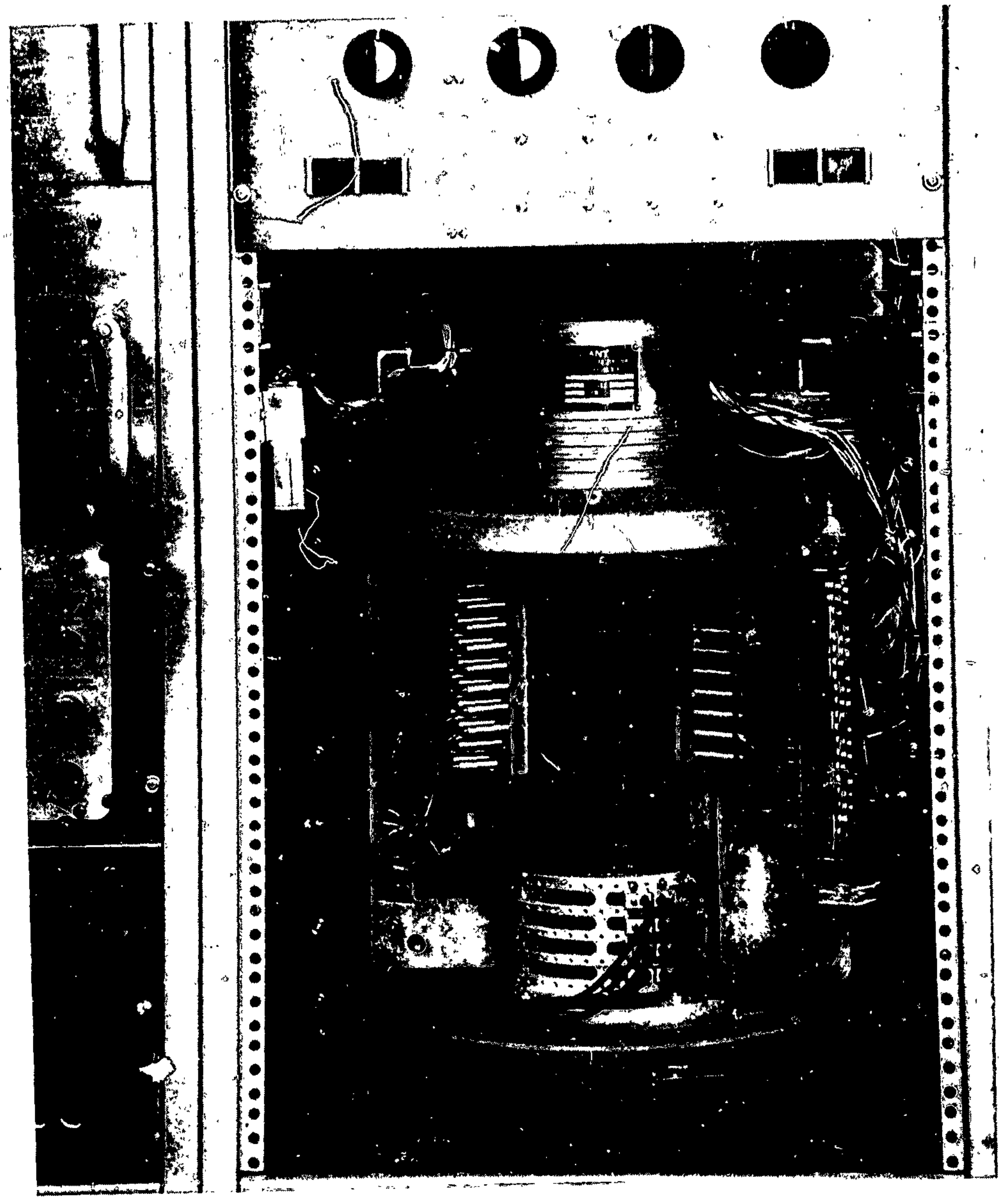


Photo by National Bureau of Standards

Provision must be included for operating local and remote displays.

The machine must concurrently process input data, transmit teletypewriter messages, and perform data processing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	3 plus sign and parity
Instructions/word	0.5
Instructions decoded	21
Instruction type	One address

Information word

t_{14}													t_1
Pe	8	4	2	1	8	4	2	1	8	4	2	1	±
Parity	10^2				10^1				10^0				Sign

A "word" in AMOS IV consists of three decimal digits and a sign. Since, in binary notation, a decimal digit can occupy as many as four bit positions, it is necessary to assign four bit positions to each decimal digit. A data word in AMOS IV looks as above.

Photo by National Bureau of Standards

Instruction Word

Word α		Operation			Channel β		
			$\pm$				$\pm$
Data word at even address				Data word at odd address			

The operations are coded in two decimal digits. The (α,β) of the word upon which the operation is performed is placed in the first two and last two decimal positions of the instruction. The sign at the end of the instruction has no bearing upon the function; the sign at the center of the instruction affects the computer's operation within predetermined modes. (In the future, when the remainder of the drum is activited, the sign at the end of the word will have significance.)

The content of each register is shown on the indicator panel.

IR - Instruction Register. The instruction being performed is stored in this register.

IAC - Instruction Address Counter. The address (α, β) of the next instruction is contained in this register.

FLEX Buffer. This is the intermediate stage for flexowriter input and output. It indicates what is being written or read by the flexowriter.

A Register. This register is used for storage in various operations.
B Register. This register is also used for storage in various operations.
IR - Index Register. The index register, two decimal digits in size, is filled by operation's (60) transferring two digits of the address into it. In the operation of the machine, if an address enters the IR which is "impossible", such as (11x11), the content of the index register replaces the α portion of the address in the IR.

ARITHMETIC UNIT

In addition to an address counter and decoding network for obtaining commutating pulses, the input circuit has a one-word shift register which serves as a buffer between the instruments and the input recording circuit. Data words from sampled instruments are inserted in the register by means of a parallel transfer, up to 13 bits at a time (three decimal digits and sign). The number representation need not be binary-coded decimal, since the computer can perform code conversion, if required.

STORAGE

Medium	No. of Words
Magnetic Drum	10,000

To store data, the machine uses a magnetic drum operating at 1800 rpm that carries 100 general storage channels of 100 words each and has space for 100 additional channels. Several dual-head channels are available for simultaneous read-in and read-out of incoming data, outgoing messages, etc. The magnetic drum provides the extensive storage capacity required for the table look-up involved in the calculations of runway visual range and approach light contact height. About 35 tables are stored on the drum; each table has about 90 three-digit values.

One set of these tables contains the data on runway visual range (RVR), i.e., the distance along the runway visible to a pilot from the point of touchdown - generally 1,000 to 6,500 feet, depending upon runway illumination (natural and artificial) and atmospheric conditions. The primary input for the RVR determination is a transmissometer reading. The computer continuously monitors this reading and "looks up" the proper corresponding value of RVR, which is then displayed locally and inserted into the teletype message.

The other set of tables contains the data on approach light contact height (ALCH), i.e., the height from which the pilot can identify the approach lights. ALCH is affected by background illumination level, atmospheric conditions, and the intensity of the approach lights, which are set in accordance with prevailing conditions. If limiting conditions are indicated by either low clouds, as shown by the ceilometer, or by fog or snow, as sensed by the transmissometer, a value of ALCH based on the interfering factor is obtained. If both factors are present, two calculations are made; the machine then determines and displays the lower value. Since there is a statistical uncertainty in this type of information, two values of altitude are presented. The higher altitude is that at which the pilot has a 20 percent probability of seeing the approach lights; the lower altitude is that at which the probability is 90 percent.

The drum operates at a conservative rate of 1,800 rpm; non-return-to-zero recording is used, with a recording density of 120 bits per inch. Thus, the machine operates at a bit rate of 50 kc.

INPUT OUTPUT

Media
Paper Tape
Keyboard
Various Analog Data Channels
Typewriter

The computer continuously monitors new input data while simultaneously processing data already entered and transmitting messages on command. Among the input quantities which the AMOS IV Computer can handle are temperature, dew point, wind speed and direction, atmospheric pressure, precipitation, transmissivity, and cloud height. Input data can be received directly from the instruments in the simplest possible form, such as analog voltage, current, or resistance; and pulse rate or contact closure. Information may also be received in coded form, such as the Gray binary code frequently used with shaft-position encoders. The nature of the weather instruments and of the quantities measured limits the input data to 2 or 3 decimal digits for the most part; word size is therefore 3 digits plus sign. Double precision methods are available for those few instances requiring greater accuracy. Communication with the machine is via electric typewriter or punched tape.

The method of receiving input data from the weather-sensing instruments is a compromise between the use of separate pre-processing devices and use of the central processor. In order to avoid excessive interruption of the central processor, varying amounts of circuitry have been assembled, depending on the form of the input data, to pre-digest the instrument signals for most efficient use of the processor. Once the data has been prepared in suitable form, generally as contact closures or storage in flip-flop registers, it is entered into the computer via an input-data track on the magnetic drum. This track is equipped with two heads, one addressable by the central processor and the other wired to the input circuitry. Since the track can store 100 words, there is an input capacity of 100 instrument readings, a quantity considerably in excess of present requirements. The address of each word identifies the reading, and the addresses therefore, are used to call out the appropriate subroutines when new data appears in the various word locations. The input devices are sampled sequentially by means of commutating pulses obtained from a decoding network attached to an address counter. It is possible with this scheme to sample any instrument within 1/30 second of the time that a desired reading is obtained. If readings were obtained at the rate of 30 per second, however, the central processor would quickly be overloaded; actually, it is sufficient to sample most instruments at intervals of once per minute or longer. The ceilometer is the most frequent with readings at 6 second intervals.

The teletypewriter outputs involve the buffering of data, which comes from the drum at a high rate, down to the desired message speed. In addition, data words must be reorganized into teletypewriter characters, including the addition of start and stop pulses, and the generation of space and sign characters. Two independent teletypewriter outputs are required, with different codes and message formats. The low-speed output is nominally 100 words per minute, while the high-speed output is in the range of 750 to 1500 words per minute. Several different message lengths are required at the higher speed, requiring that the

circuitry be capable of skipping unwanted portions of the message. Since the messages are to be combinations of data prepared by the computer and alphanumeric remarks and text inserted by hand, several tracks have been allowed on the drum for this information. Certain tracks, addressable by the computer, contain the numerical data. Other tracks may be written into only from the automatic typewriter, and are used for the remarks. These are all dual-head tracks, with one set of heads being used to insert data, either from the processor or the typewriter, while the other set is used to read out the information.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

The computer circuitry is based on transistorized plug-in assemblies designed at NBS for a variety of data-processing applications. These 50-kc packages perform flip-flop, analog switch, and gating circuitry functions, as well as others.

CHECKING FEATURES

Parity. This pushbutton-light indicates when parity has been lost in the memory circuits. AMOS IV operates on an even parity system. As each word is written into the memory, the number of binary "1's" is counted. If the number of 1's is even, a "0" is placed in the parity bit position. If the number of 1's is odd, a "1" is placed in the parity bit position; thus, any word in the memory plus its parity bit contains an even number of 1's in its binary notation.

Upon read-out of a word from the memory, a check is made for this "even 1's" characteristic. If, through an error in the recording process, parity does not check, the parity light is operated and remains lighted until the parity control button is depressed.

This light is a warning light, indicating that some malfunction has occurred in the read process. Depressing the parity button resets the parity system.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The circuits are designed to permit wide variations from the nominal values of the characteristics and parameters of the components.

The electrical outputs from most of the packages can be short-circuited to ground or to the negative voltage supply without damage to any of the components.

Pin-type connectors with high-pressure contacts are used rather than printed-circuit edge-type connectors.

Signal swings are at least 6 volts, with a collector supply of -12 volts.

All connectors have gold-plated pins.

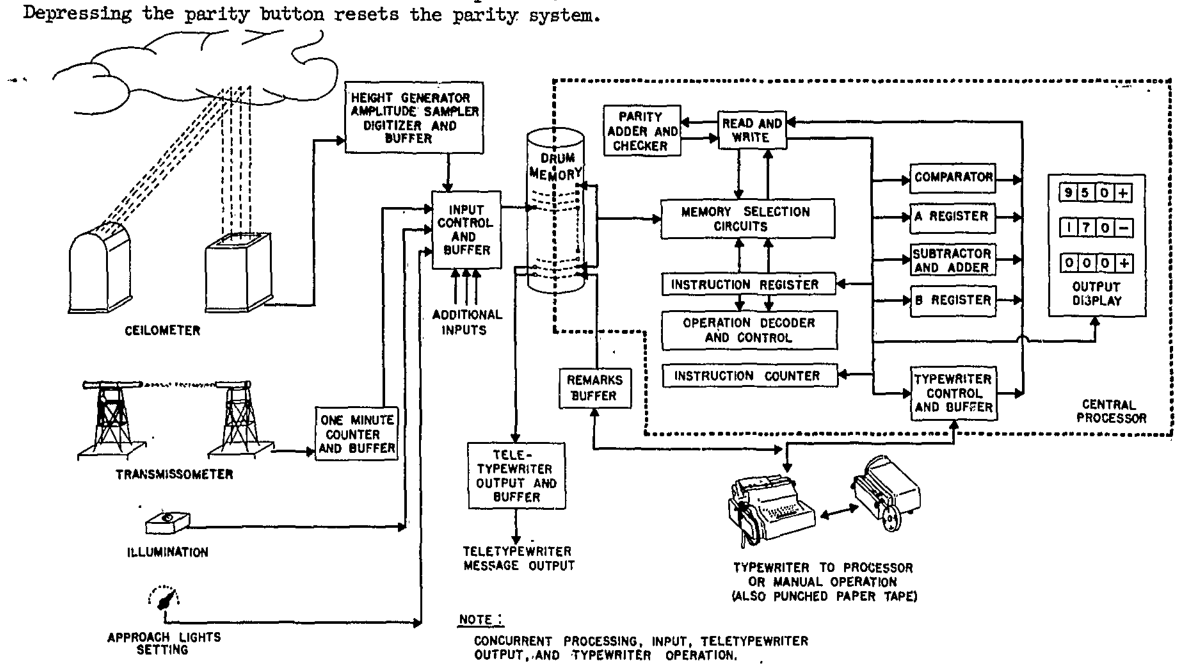
All back panel wiring is by taper pins for ease and convenience in making external connections. Taper pins also eliminate solder joints.

ADDITIONAL FEATURES AND REMARKS

A need for improved reporting of weather data has been brought about by the requirements of modern, high-performance aircraft, together with the advent of high-speed computers for use in weather forecasting. Manual methods of recording meteorological observations introduce an undesirable time delay, increase the chance of error, and limit the frequency of observations. A solution to this problem lies in the use of automatic data processing equipment for the recording, pre-processing, and transmission of the information. Under the sponsorship of the U. S. Weather Bureau, the National Bureau of Standards has developed a specialized computer for use as a research tool in exploring this concept.

INSTALLATIONS

National Bureau of Standards
Washington 25, D. C.



AN/ASQ 28 (v) EDC

AN/ASQ 28 (V) Emergency Digital Computer

MANUFACTURER

International Business Machines Corporation
Federal Systems Division

APPLICATIONS

System is designed and used as a general purpose stored program computer for manned aircraft bombing, navigation and missile guidance subsystem. It may be utilized for real time control of processes of small capacity. The central computer is general purpose while the input-output equipment is special purposes.

Designed and developed under contract no's AF 33 (600)36599 and AF 33(600)41253 as a minimal emergency back-up computer to the main computer of the AN/ASQ-28(V) Bombing, Navigation and Missile Guidance Subsystem of the B-70 aircraft.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	26
Binary digits/instruction	26
Instructions per word	1
Instructions decoded	10
Arithmetic system	Fixed point Sign and Magnitude
Instruction type	One plus one (Operand and next instruction)
Number range	Plus and minus 23 bits accuracy

Instruction word format

S	W1	W2	W3	T1	T2	T3	T4	T5	W1	W2	W3	W4	W5	W6	T1	T2	T3	T4	T5	T6	01	02	03	04	P
	Operand Address								Next instruction address												Operation				

P = Parity
S = Switching

Registers include a Multiplier-Quotient revolver, an accumulator, and an instruction revolver.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	624	156
Mult	3,744	3,276
Div	3,744	3,276

Construction (Arithmetic unit only)

Transistors	60 - 5 Types
Diodes	290 - 6 Types
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits/Word	Access Microsec
Drum	Instructions and Constants - 3456 Data - 384	26	Min - 156 Max - 5000

Instructions can be optimumly located to permit a minimum memory access time. Fast intermediate data access time provided by revolvers on the drum.

INPUT

Media	Speed
Decimal Insert	Random
Shaft-to-Digital	100 words/sec/device
Pulse Trains	Variable
Discrete Signals	Variable

Manual insert is by 7 decimal digits. 48 instrumental discrete signals may be inserted.

OUTPUT

Media	Speed	
Discrete Signals	Variable	32 instrumented
Decimal Display	Variable	7 Decimal digits
Digital-to-Shaft	100 words/sec/device	
Pulse Train	Variable	

The decimal display is seven digits long. 32 instrumented discrete output signals are obtainable. A high speed input-output processor is provided which performs a number of functions coincidently with the central processor. 48 parameters can be processed at a rate of 4800 operations per second.

System characteristics include updating of digital servo loops, determination of first order clamp for digital servo loop, accumulation and generation of pulse train inputs and outputs, buffering of decimal display word, acceptance of manual insert register word, and reading and decoding of shaft-to-digital encoder inputs.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	4,395
Transistors	592

These figures include the central computer and input-output processor. They do not include special input-output equipment required for special applications.

CHECKING FEATURES

Transfer parity check is built in.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.25 Kw
Volume, computer	1.9 cu ft
Weight, computer	81 lbs

These figures include the central computer and input-output processor. They do not include special input-output equipment required for special applications.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

This equipment is designed to meet stringent reliability requirements for a supersonic military aircraft environment. The ambient temperature range is 0°C to 100°C. All circuits use silicon transistors and diodes and are designed for ultrareliable operation from 0°C to 100°C. Reliable drum readout signals are provided by air floated drum heads.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include replaceable (pluggable) subassemblies, nonerasable drum tracks to prevent accidental destruction of the stored program, intercommunication provided with a main digital computer through a common drum track link, unique high speed input-output processor with a repetition rate greater than the computation cycle of the basic computer, and 48 programmed discrete inputs for program branching and 32 discrete outputs for system control.

Unique system advantages include rugged environmental specifications, high reliability, and flexibility.

AN/ASQ 28 (v) MDC

AN/ASQ 28 (V) Main Digital Computer

MANUFACTURER

International Business Machines Corporation
Federal Systems Division

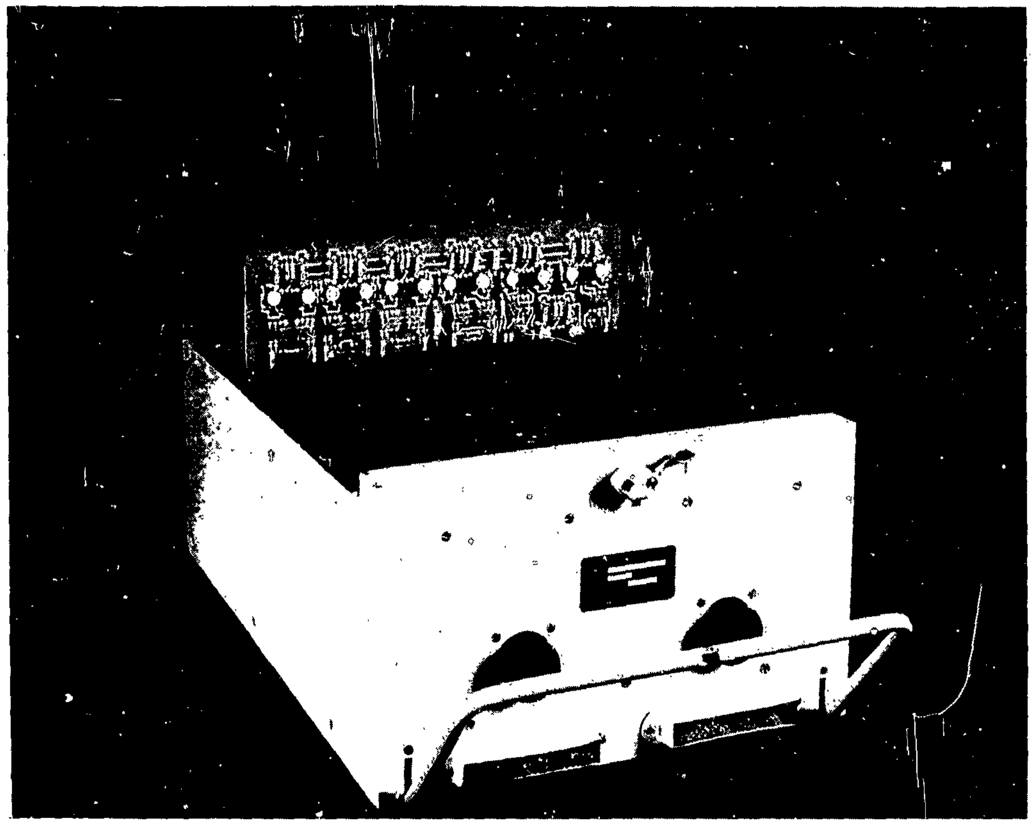


Photo by International Business Machines Corporation
Subassembly Drawer, containing Printed Circuit Boards

APPLICATIONS

Designed for general purpose stored program computer for manned aircraft bombing navigation and missile guidance subsystem. Applicable to real time control of processes (large capacity). The central computer is general purpose while the input-output equipment is special purpose.
System was designed and developed under contract no's AF 33(600)36599 and AF 33(600)41253 as the central computing element for the AN/ASQ-28(V) Bombing, Navigation and Missile Guidance Subsystem of the B-70 aircraft.

PROGRAMMING AND NUMERICAL SYSTEM

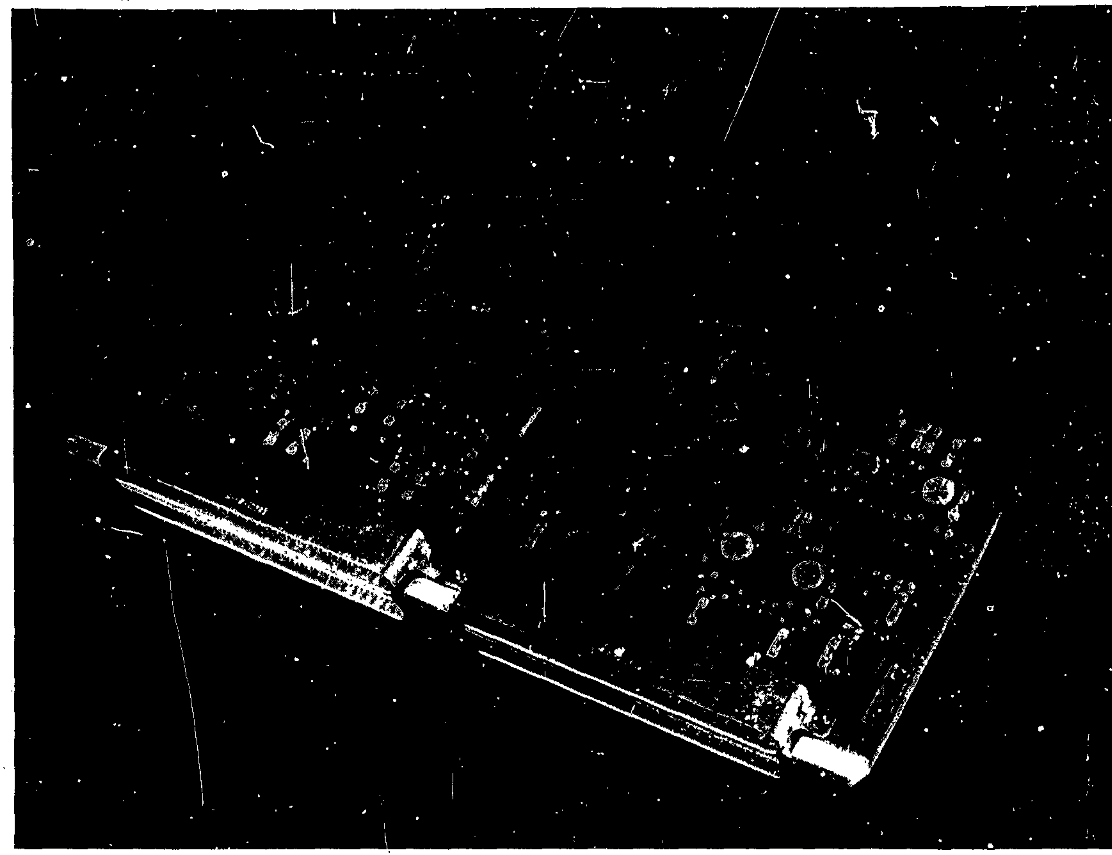
Internal number system	Binary
Binary digits/word	22 plus sign and parity
Binary digits/instruction	16 including parity
Instructions per word	1
Instructions decoded	14
Arithmetic system	Fixed point Sign and Magnitude
Instruction type	One address
Number range	Plus and minus 22 bit accuracy

Instruction word format

P	M	S6	S5	S1	S2	S3	S4	R1	R2	R3	R4	O1	O2	O3	O4

P = parity
M = modifier
R1-R4, S1-S6 = address
O1-O4 = operation

Registers include multiplier-quotient, accumulator, check register, and memory buffer.
An instruction word is read from drum storage 4 bits parallel by 4 bits serial. A constant word is read from drum storage 6 bits parallel by 4 bits serial.



Printed Circuit Board

Photo by International Business Machines Corporation

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	24	24
Mult	264	264
Div	288	288

Construction (Arithmetic unit only)

Transistors	249 - 5 Types
Diodes	2,726 - 6 Types
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

The feature of instruction overlap is incorporated which permits the reading of instructions and performing arithmetic operations simultaneously.

STORAGE

Media	No. of Words		No. of Digits/Word	Access Microsec
Cores	1,024		24	24
Drum	26,624	Instructions	16	
	6,656	Constants	24	5,000 avg.

Minimum drum access time is 24 microseconds.

INPUT

Media	Speed
Decimal Insert	Random (Manual) 7 decimal digits
Shaft-to-Digital	100 words/sec/device
Pulse Trains	Variable
Discrete Signals	Variable 96 instrumented

Seven decimal digits are inserted. 96 instrumented discrete signals may be entered.

OUTPUT

Media	Speed
Discrete Signals	Variable
Two Decimal Displays	Variable
Decimal Printer	Variable
Digital-to-Shaft	100 words/sec/device
Pulse Trains	Variable

Eighty instrumented discrete signal outputs are available. The displays and printer utilize 7 decimal digits. A high speed input-output processor is provided which performs a number of functions coincidently with the central processor. 52 parameters can be processed at a rate of 5,200 operations per second. The following characteristics are involved:

Updating of digital servo loops.

Determination of first order clamp for digital servo loop.

Accumulation and generation of pulse train inputs and outputs.
Buffering of decimal printer word.
Buffering of decimal display word.
Acceptance of manual insert register word.
Reading and decoding shaft-to-digital encoded inputs.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Types	Quantity
Diodes	13,076
Transistors	1,697

These figures include the central computer and the input-output processor. They do not include special input-output equipment required for special applications.

CHECKING FEATURES

Checking features include a random error counter, parity and timing check circuitry, and Test Point compare. The random error counter minimizes the effects of random and intermittent errors on system performance. Built in test equipment enables rapid fault location.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.8 Kw
Volume, computer	7.4 cu ft
Weight, computer	Approx 260 lbs

These figures include the central computer and input-output processor. They do not include special input-output equipment required for special applications.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

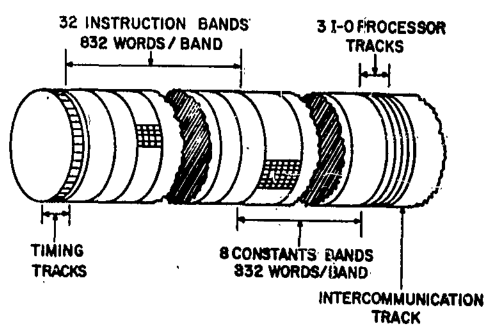
This equipment is designed to meet stringent reliability requirements for a supersonic military aircraft environment. Ambient temperature range is from 0°C to 100°C. All circuits use silicon transistors and diodes and are designed for ultra-reliable operation from 0°C to 100°C. Reliable drum readout signals are provided by air floated drum heads.

ADDITIONAL FEATURES AND REMARKS

Outstanding features are replaceable (pluggable) subassemblies, nonerasable drum tracks to prevent accidental destruction of the stored program, intercommunication provided with an emergency digital computer through a common drum track link, built-in checking circuitry minimizes effects of random and intermittent errors on system performance, a new hardware approach to fault isolation, supplemented by simplified diagnostic programs, which permits rapid location of computer failure, a unique high speed input-output processor with a repetition rate greater than the computation cycle of the basic computer, and 96 programmed discrete inputs for program branching and 80 programmed discrete outputs for system control.

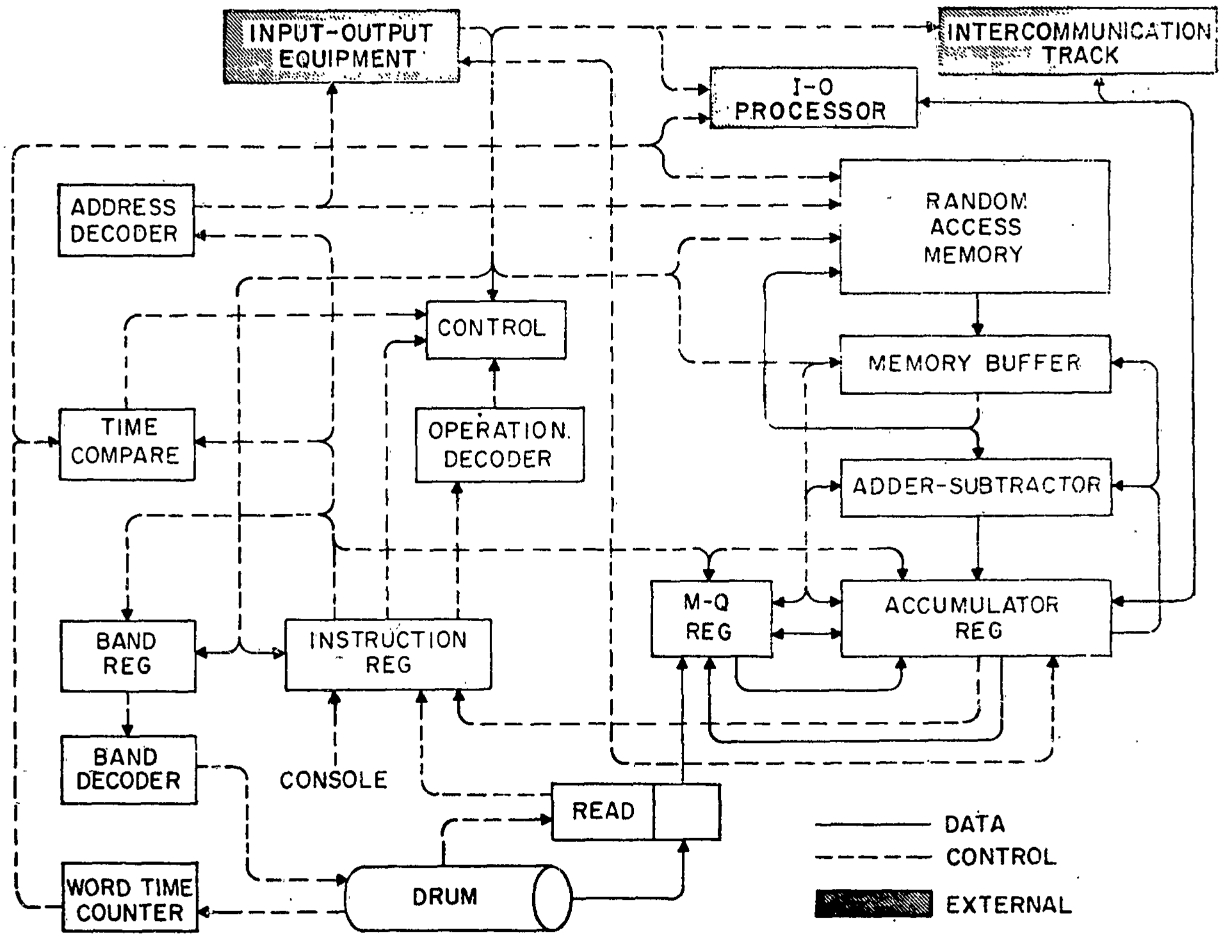
Unique system advantages include rugged environmental specifications, high reliability, flexibility and ease of maintenance.

During normal operation of the bombing, navigation and missile guidance subsystem, a high-speed, parallel computer with both a random access memory and a magnetic drum memory performs all calculations required by the subsystem. If the main computer malfunctions, a moderate speed, serial, all-drum computer automatically assumes control and generates solutions to a simplified problem. Repair of the main computer is then possible without disturbing the remainder of the subsystem.



Main Computer Drum Organization

Diagram by IBM



Flow Diagram of Main Central Computer

Diagram by International Business Machines Corp.

AN/FSQ 7 AN/FSQ 8 (SAGE)

IBM AN/FSQ 7 and 8 (Semi Automatic Ground Environment)

MANUFACTURER

International Business Machines Corporation

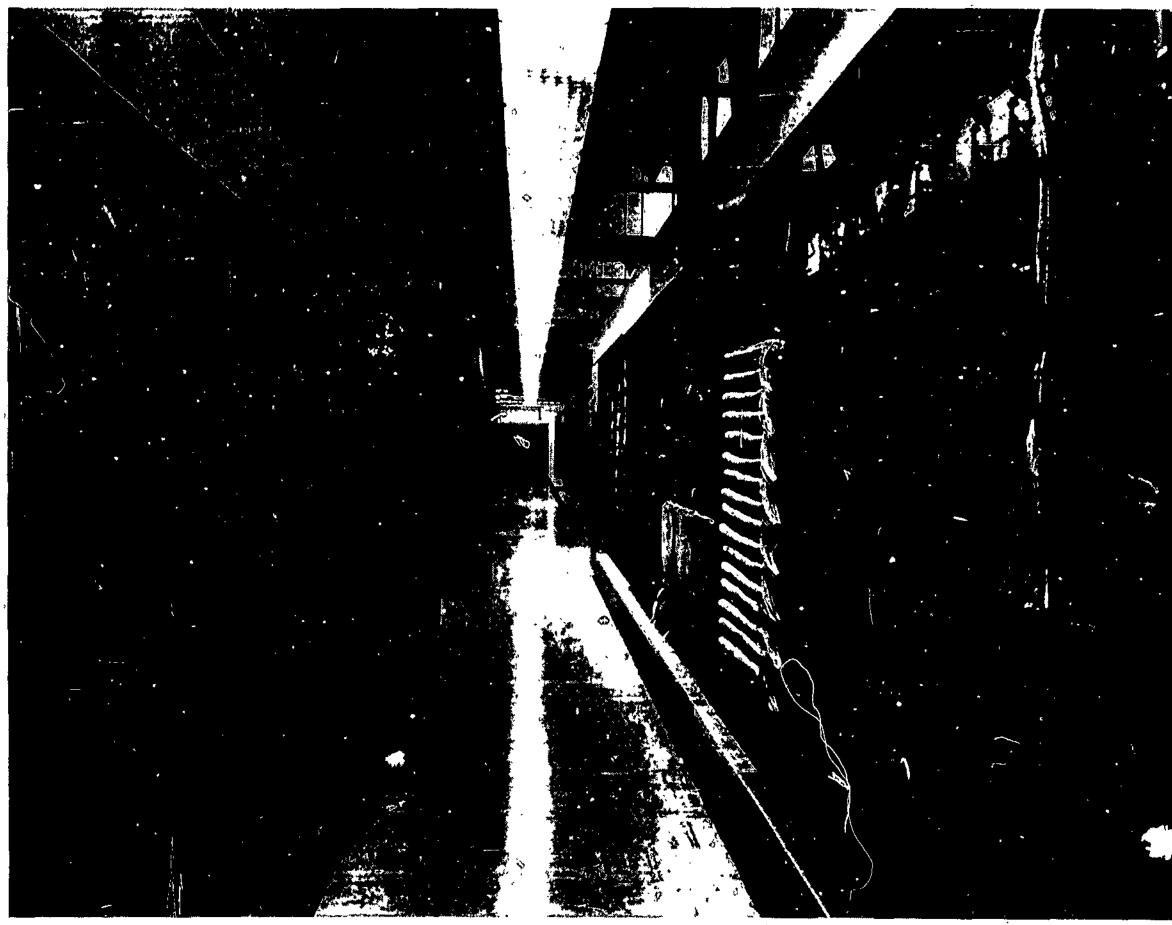


Photo by Systems Development Corporation

APPLICATIONS

Manufacturer

Real time for Air Defense (SAGE) - Semi Automatic Ground Environment.

The AN/FSQ-7 is a Real Time Digital Computer at the heart of each SAGE Air Defense installation. At electronic speed the computer processes radar data, performs complex computations and displays visually the current air defense situation to Air Force personnel for assigning the appropriate weapons for interception.

System Development Corporation

Located at 2500 Colorado Avenue, Santa Monica, California, system is presently being used for design analysis and development checkout of SAGE computer programs.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

(SAGE is a duplexed computer system. Information quoted is for one simplex computer.)

Internal number system	Binary
Binary digits/word	32 + 1 parity
Binary digits/instruction	32 + 1 parity
Instructions per word	1
Instructions decoded	61
Arithmetic system	Fixed point

Dual arithmetic unit with left and right half

The instruction, set through programming methods, permits binary coded decimal and floating point to be simulated.

Instruction type	One address

Single address with indexing capability

Number range	2^{15} in each half word

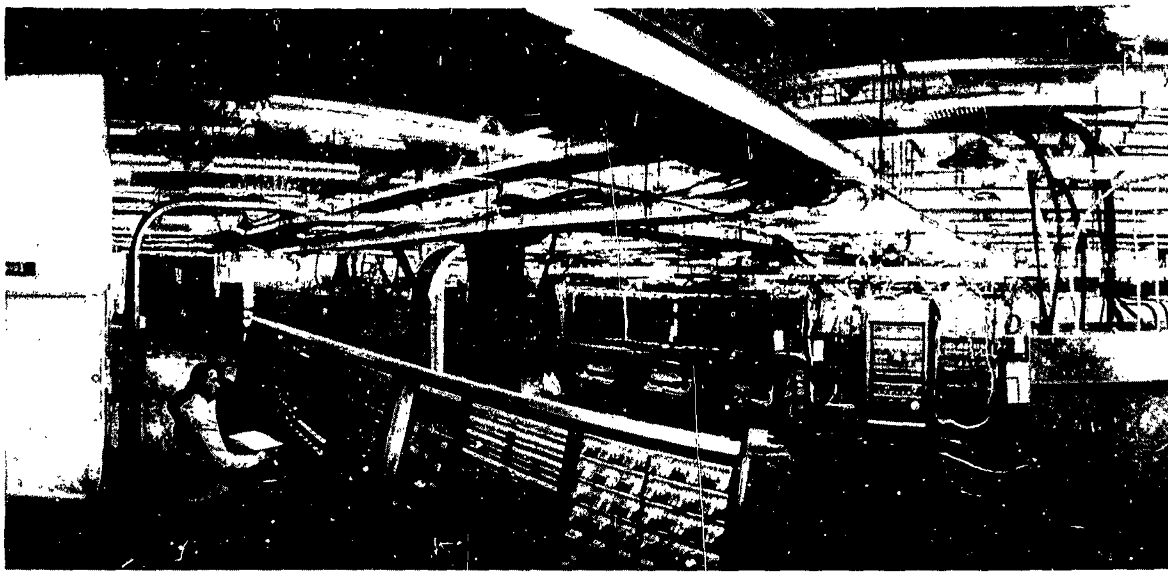


Photo by International Business Machines Corporation

Instruction word format

Left Hand Word

P	L S	L 1	L 2	L 3	L 4	L 5	L 6	L 7	L 8	L 9	L 10	L 11	L 12	L 13	L 14	L 15

Right Hand Word

R S	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15

L1, L2, L3:	Index Register Selection Bits
L4, L5, L6, L7, L8, L9, L10:	Instruction Code Bits
L10, L11, L12, L13, L14, L15:	Index Interval Bits
RS through R15:	Data Address
P =	Parity Bit
S =	Sign Bit

Automatic built-in subroutines include Start from Test Memory, Load from Card Reader, Load from AM Drums, Clear Memory, and Master Reset.

Automatic coding includes Compass, Lincoln Utility, and Jovial.

Registers

4 Index Registers
1 Memory Buffer Register
1 "A" Register
1 Accumulator
1 B Register
1 I/O Register
1 Drum Control Register
1 I/O Word Counter Register
1 Program Counter Register
1 Address Register
1 I/O Address Register
3 Memory Address Registers
1 Test Register
1 MI Register

ARITHMETIC UNIT

Manufacturer (Simplex Computer)	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	12	6.0
Mult	16.5	10.5
Div	51.0	45.0
Arithmetic mode	Parallel	
Timing	Synchronous	

Internal computer operations are synchronous. However, input data can be handled at a random rate.

Operation Sequential and concurrent

The Stored Program computer with sequential execution of programmed instructions. Through the use of buffer storage devices (drums) input, output, arithmetic operations can be accomplished concurrently.

STORAGE

Manufacturer (Simplex Computer)

Media	No. of Words	No. of Binary Digits/Word	Access Microsec
Ferrite Memory (Core)	69,632	33	6
Magnetic Drums	135,168	33	10
Magnetic Drums	18,432	24	10

Drum access time is for each consecutive word.

Magnetic Tape

No. of units that can be connected	8 Units
No. of chars/linear inch of tape	248 Chars/inch
Channels or tracks on the tape	6 Data, 1 control Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	18,750 Chars/sec
Start time	5 Millisec
Stop time	5 Millisec.

Average time for experienced operator to change reel of tape 60 Seconds

Physical properties of tape

Width	1/2 Inches
Length of reel	2,400 Feet
Composition	Mylar or cellulose acetate base

System Development Corporation

Media	No. of Words	No. of Binary Digits/Word	Microsec
Core	69,632	33	6
Drum	153,600	33	10,000

INPUT

Manufacturer
(Simplex Computer)

Media	Speed
Cards	150 cards/min, 24 words/card
Magnetic Tape	3,086 words/sec
Manual Inputs	Random
Automatic Inputs	Random LRI-GFI, Xtell

System Development Corporation

Magnetic Tape 75 feet/sec

248 characters per inch, 1.2 million words per reel. 3,000 words/sec read-write time.

Card 150 cards/min

Hollerith contains 1 instruction word per card. Binary contains 24 instruction words per card.

OUTPUT

Manufacturer
(Simplex Computer)

Media	Speed
Printer	150 lines/min
Punch	100 cards/min
Display	Random

Digital Display & Situation Display

Automatic Outputs Random

TTY, G/AFD, G/A TD, G/G

LRI: Long Range Radar Inputs from distant radar sites are received at random, processed and stored for use by the computer.

GFI: Gap Filler Radar Inputs: A separate element processing and storing data in a manner similar to LRI.

Xtell: Coded Digital messages from adjacent SAGE computers received at random, processed and stored for use by the computer.

TTY: Teletype output capability for computer generated messages.

G/AFD: Ground to Air Frequency Division output capability for computer generated messages.

G/ATD: Ground to Air Time Division output capability for computer generated messages.

G/G: Ground to Ground output capability for computer generated messages to other SAGE computers.

System Development Corporation

Media	Speed
Cards	100 cards/min

Binary is normal output. Hollerith can be outputed.

Tape	25 ft/sec
Printer	150/500/5,000 lines/min

Printer - IBM 717, 720A and SC 5000.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer
(Duplex)

Type	Estimated Quantity
Tubes	50,000
Diodes	170,000
Transistors	703
Magnetic Cores	4,603,904

CHECKING FEATURES

Manufacturer

Parity, inactivity, overflow, fix programming (Self detecting, error correcting program routine which corrects approximately 95% of all errors without manual intervention.)

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

All values are for duplex system

Power, computer	750 Kw 0.65 DC Supplies 1.0 Filaments
Volume, computer	337,500 cu ft
Area, computer	22,500 sq ft
Room size	150 ft x 150 ft
Floor loading	150 lbs/sq ft
Weight, computer	275 Tons

Site preparation requirements

Computer plenum, requirements are 150 x 150 x 6 = 135,000 cu ft.

Display system requires additional 35,000 sq ft of floor space.

The Display area has a special hexcel ceiling and controlled blue lighting.

Building is climatically controlled, reinforced concrete construction, no windows.

All power is self-contained within the compound.

The square footage is divided into four separate areas: A Computer, B Computer, Simplex and Maintenance and Programming.

The air conditioning equipment is not provided by IBM.

System Development Corporation

Power, computer	1500 Kw 1875 KVA 0.8 pf
Power, air cond	288 Kw 360 KVA 0.8 pf
Volume, computer	10,450 cu ft
Volume, air condition	8,500 cu ft
Area, computer	1,508 sq ft
Area, air condition	1,250 sq ft
Room size, computer	100 ft long 76 ft wide 20 ft high
Room size, air condition	36 ft long 16 ft wide 20 ft high
Floor loading	150 lbs/sq ft
Capacity, air conditioner	500 Tons
Weight, computer	113.1 Tons, total

The building was constructed by the Air Force using specifications furnished by IBM for the specific purpose of housing the computers, power and air conditioning equipment, the space for support equipment (EAM) and operating and maintenance personnel. Above figures are approximate.

PRODUCTION RECORD

Manufacturer

Number produced to date 25 (25 duplex systems equals 50 units)
Number in current operation 23
Number in current production 1
Time required for delivery 16 months

PERSONNEL REQUIREMENTS

Manufacturer

The personnel requirements are dependent upon the intended application and requirements (reliability and shift policy) of the equipment as established by the Air Force. The experience to date would not necessarily be a criteria for all equipment applications.

Training of operators, maintenance personnel, programmers, and customer management is available on the basis of specific contract negotiation.

System Development Corporation

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	Used	Recom	Used	Recom	Used	Recom
Supervisors	12	12	14	14	16	16
Analysts	10	10				
Programmers	500	500				
Clerks	11	11	16	16		
Operators	7	10	13	17	19	20
Engineers	10	7	20	14	30	21
In-Output Oper	Covered under Operators					
Tape Handlers	Covered under Operators					

Operation tends toward open shop.
Programming and System training staff.
Five weeks of concentrated programming training and three weeks of associated System training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

The four years of field operating experience on this equipment has proven it to be reliable. Quality control and sound engineering has contributed to maximum reliability and maintainability.

System Development Corporation

Average error-free running period 13 Hours
Good time 116.76 Hours/Week (Average)
Attempted to run time 120 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 97.3
Above figures based on period 1 Jan 60 to 28 May 60
Passed Customer Acceptance Test Nov 57
Time is not available for rent to outside organizations.

The total hours on the air is 144 (6 days/week).
The total maintenance hours is 24 hours/week (4 hours/day).
The available operational time = 120 hours/week (20 hours/day).

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include large capacity internal memory, automatic recovery program (self-checking), BOMARC control capability, high reliability, and automatic marginal checking.

Unique system advantages include six or nine tube pluggable unit packaging with printed circuits which enable quick replacement by a spare, visual display capability to assist in tracking and identifying aircraft and assist in selecting and directing weapons, duplex switching to increase reliability.

Tapes used with the AN/FSQ-7 are form the standard IBM commercial product line. The same precautions are applicable in tape handling.

The system is to ensure reliable around-the-clock air defense.

System Development Corporation

Outstanding features include a 16 bit half word arithmetic logic for convenience in two dimensional geometric calculations.

Unique system advantages include a large auxiliary memory in the form of drums, permitting flexibility in the manipulation of complex multi-program systems.

FUTURE PLANS

Manufacturer

It is planned to provide a modest product improvement program for the indefinite future.

INSTALLATIONS

System Development Corporation
2500 Colorado Avenue
Santa Monica, California

AN/FSQ 31 (v)

SAC Data Processing Subsystem AN/FSQ 31 (V)

APPLICATIONS

The Q-31-V is a general purpose scientific computing and data processing system control applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	48 + 2 parity bits
Binary digits/instruction	48 + 2 parity bits
Instructions per word	1
Instructions decoded	69
Arithmetic system	Fixed and floating point
Instruction type	One address
Number range	

Sign, 11-bit characteristic, and 36 bit mantissa on floating point. Ones complement binary arithmetic, sign + 47 data bits on fixed point.

An automatic coding system has been developed by the customer.

Register and B-boxes include 8 index registers, expandable to 13. 22 internal registers have specific addresses which may be used in the address portion of the instruction, i.e., program register, accumulator "B" register, etc. 4 switch registers have specific addresses. 32 plug-board registers also have specific addresses.

Sixty nine basic instructions are decoded. The use of the operation code modifiers in conjunction with the basic instruction provides the capability of decoding 771,716 effective instructions.

When performing fixed point operations a data word may be treated as a sign plus 47 data bits or may be split into two half words of sign and 23 data bits. These half words may be operated on either with the right or left half only or with both halves at the same time but independently, in the arithmetic section. There are three ways of addressing (a) Real data - the right half of the instruction is the operand to be used. (b)Direct Address - the address portion of the word specifies the location of the data (c) Indirect Address - the address portion of the word specifies the location of another address which may specify the location of the data. This function may be recursive.

There are two basic instruction forms. Form "A" is used for all instruction except the decrement class. Form "B" is used only for the decrement class instructions. The decrement field of the decrement class instruction is the same number of bits in length as the index registers because these instructions work with or on the index registers.

Data may also be handled in 6 bit groups called "bytes" with an ability being provided to manipulate these bytes in many ways. Manipulation of bits within a byte (as specified by the instruction) is also possible.

MANUFACTURER

International Business Machines Corporation
Federal Systems Division

ARITHMETIC UNIT

Operation Time	Including Storage Access Microseconds Fixed	Floating
Add	2.5	5-27.5
Mult	14-58	14.5-61.5
Div	70	56.5-63.5

Construction (Arithmetic unit only)

Transistors	9,800	Special MADT
Condensers	19,100	Corning Glass and Mica
Diodes	21,400	
Transformers	2,700	
Resistors	48,200	Special, 5%, carbon
Arithmetic mode	Parallel	
Timing	Synchronous	
Operation	Concurrent	

The instruction times including and excluding memory access are the same because of the overlap of the instructioned coding with the fetch time of the operand. The two level decoding structure permits this.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Ferrite Core	65,536 (expandable to 131,072)	3,276,800 to 6,553,600	2.5
Mag. Drums - Aux. Storage	139,264/drum (max of 557,056)	6,963,200 to 27,852,800	

Magnetic Tape

No. of units that can be connected	24 expand to 48 Units
No. of char/linear inch of tape	556 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	41,667 Chars/sec
Start time	3.65 Millisec
Stop time	3.65 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	1/2 Inch
Length of reel	2,400 Feet
Composition	Acetate, Mylar

Magnetic Drum access time; maximum 22.5 milliseconds, average 11 milliseconds, minimum 11 microseconds, consecutive transmission 2.75 microseconds/word. A system may be expanded to handle two drum adapters and eight physical drums increasing the maximum storage to 1,114,112 words. Up to 3 of the 24 tape units may be operating on-line as input/output devices simultaneously.

INPUT

Media	Speed
Cards	250 cards/min
Typewriter	Typing Speed
Data Channel	32 microsec/word

There are 12 full words and 12 half words on each input card. The data channel can receive 1/2 word every 16 microseconds.

OUTPUT

Media	Speed
Cards	100 cards/min
Typewriter	600 char/sec
Data Channel	32 microsec/word
Printer	600 lines/min
	132 char/line

The data channel is actually a communications link with a smaller computing system operating as a message switching/processing complex.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	
Diodes	229,000	Special high speed design
Transistors	138,000	Special MADT Design
Magnetic Cores	3,276,800	Ferrite

CHECKING FEATURES

100% single error detection with the capability of programmed error correction.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer (initial) 109.05 Kw 168 KVA 0.65 pf
Power, computer (expanded)147.47 Kw 227 KVA 0.65 pf
Power, air cond, internal, liq cooled 62.25 Kw
Power, air cond, internal, air cooled 14.00 Kw
Power, air cond, external air cooled 89.89 Kw
Volume, computer 4,825 cu ft
Area, computer 740 sq ft
Area, computer, maint and prog 4,250 sq ft
Area, maint, test and store 1,425 sq ft
Floor loading, structural design 150 lbs/sq ft
Weight, computer, total, SAC initial 105,650 lbs
Capacity, air conditioner, external 23.2 Tons
Site preparation requirements
Power equipment installation consisting of power distribution unit, frequency-converters, and M-G sets for prime power regulation. Maintenance room provisions for a-c regulators shall be installed.
Installation of heat exchanger for liquid cooling purposes.
Compressed air provision for drum units.
Forced air cooling for memory required. Segregated race-way systems (for signal and power) shall be provoded for overhead at a height of 8'-8" and 9'-8" respectively.
Room air conditioning for personnel comfort.
Liquid cooling accommodations for transistorized equipment shall be provided.
Dias is desirable with access ramp and/or stairs due to underfloor cabling requirements for commercial equipment.
Leveling channels shall be installed for uniform floor loading for computer equipment.
Minimum 8 foot door heights have to be provided.
Power Emergency-Off system located within the building should be provided.
Lighting system for equipment installation and maintenance purposes (minimum average of 50 foot-candles illumination at the floor level.)
Adequate administrative office area must be provided.

PRODUCTION RECORD

Number in current production 3
Number on order 3

PERSONNEL REQUIREMENTS

Personnel requirements are established on the basis of reliability and shift requirements established by the user.

Training of operators, maintenance, programmer and customer executive personnel is available on the basis of specific contract negotiation.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability include error detection hardware enables 100% single failure detection, specific hardware in the machines used for the FIX error correction concept, where by an intermittent single error may be corrected by programming means, specific hardware connected with FIX is used to isolate a solid failure to a minimum number of circuit elements (Q-Pacs), and circuit design was accomplished utilizing an "End-of-life" technique. Marginal checking capability is provided to enable the operation of the system with marginal voltages. Marginal conditions may be controlled either manually or by program means. Diagnostic Programming Techniques are employed in conjunction with marginal checking to assist in locating circuit elements which have not yet failed but may be about to fail. Operating Experience-Prototype of system is currently under reliability evaluation.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a very sophisticated instruction list, machine design which permits very efficient usage for either data processing tasks or scientific usage. Semi-variable field ability not usually found with high speed arithmetic operations. Machine desing permits use of many advanced programming techniques, i.e., direct or indirect addressing, single or double indexing, most internal registers are addressable. Ultra reliable design philosophy is used throughout the system. System was designed primarily as a real time control system for a wide range of command and control applications. In addition to a very powerful general purpose computer, the system has facilities for expansion (or contraction) in all storage and input/output area to meet a large variety of real time control and computing demands. Error detection and correction design insure high reliability. The tape utilized on this system is from the standard IBM product line.

Anticipated installation date of first system is the fourth quarter of 1960. The system described here may also be implemented as a completely duplexed installation with very effective communication links from one computer to the other.

FUTURE PLANS

A modest product improvement program is planned.

INSTALLATIONS

Strategic Air Command

AN/FSQ 32

AN/FSQ 32

MANUFACTURER

International Business Machines Corporation
Federal Systems Division

APPLICATIONS

General purpose scientific computing and data processing system with emphasis on real-time control applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	48 + 2 parity bits
Binary digits/instruction	48 + 2 parity bits
Instructions per word	1
Instructions decoded	69
Arithmetic system	Fixed and floating point
Instruction type	One address
Number range	

Sign + 47 data bits fixed point, Sign + 36 bit mantissa 11 bit characteristic floating point.

An automatic coding system has been developed by the customer.

Registers and B-boxes

8 index registers expandable to 13.22 internal registers have specific addresses which may be used in the address portion of the instruction. (i.e., Program register, accumulator "B" register, etc.)
4 Switch registers also have specific addresses.
32 plug-board registers also have specific addresses.

Sixty nine basic instructions are decoded. The use of the operation code modifiers in conjunction with the basic instruction provides the capability of decoding 771,716 effective instructions.

When performing fixed point operations a data word may be treated as a sign plus 47 data bits or may be split into two half words of sign and 23 data bits. These half words may be operated on either with the right or left half only or with both halves at the same time but independently, in the arithmetic section. There are three ways of addressing (a) Real data - the right half of the instruction is the operand to be used. (b) Direct Address - the address portion of the word specifies the location of the data. (c) Indirect Address - the address portion of the word specifies the location of another address which may specify the location of the data. This function may be recursive.

There are two basic instruction forms. Form "A" is used for all instruction except the decrement class. Form "B" is used only for the decrement class instructions. The decrement field of the decrement class instruction is the same number of bits in the length as the index registers because these instructions work with or on the index registers.

Data may also be handled in 6 bit groups called "bytes" with an ability being provided to manipulate these bytes in many ways. Manipulation of bits within a byte (as specified by the instruction) is also possible.

ARITHMETIC UNIT

Operation	Including Storage Access Microseconds Fixed	Floating
Add	2.5	5-27.5
Mult	14-58	14.5-61.5
Div	70	56.5-63.5

Construction (Arithmetic unit only)

Transistors	9,800
Condensers	19,100
Diodes	21,400
Pulse Transformers	2,700
Resistors	48,200
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

The instruction times, including and excluding memory access time, are the same because of the overlap of the instruction decoding with the fetch of the operand. Two level decoding structure permits this.

STORAGE

Media			Access Microsec
Ferrite Cores	81,920 expandable to 163,840	4,096,000 to 8,192,000	2.5 (complete memory cycle)
Aux. Storage	139,264 exp. to 557,056	6,963,200 to 27,825,800	
Dator Storage	139,264	6,963,200	

Magnetic Drum access time, Aux. storage maximum 22.5 milliseconds, average 11 milliseconds, and minimum 11 microseconds. Consecutive transmission time is 2.75 microseconds. The dator drum is used with the output system and the data to be sent out must be put on the drum in specific patterns to enable the correct operation of the output system.

Magnetic Tape

No. of units that can be connected	24 Units
No. of chars/linear inch of tape	556 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	112.5 Inches/sec
Transfer rate	62,500 Chars/sec
Start time	3.65 Millisec
Stop time	3.65 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	1/2 Inches
Length of reel	2,400 Feet
Composition	Acetate or Mylar

INPUT

Media	Speed
Crosstell	1,300 bits/sec 32 channels, max
Long Range Radar	1,600 bits/sec 40 channels, max
Low Data Rate (LDR)	60-75-100 words/min 32 channel max, 5 bits/word
	53-66-88 words/min 6 bits/word
Card	200 cards/min
12 full words and	12 half words/card
Typewriter	Typing speed

OUTPUT

Media	Speed
Ground to Ground	1,300 bits/sec 25 channels max
Ground to Air	1,300 bits/sec 8 channel max
Teletype	Same as LDR 25 channel max
Card Punch	100 cards/min
12 full words and	12 half words/card
Typewriter	600 cards/min
Printer	600 lines/min 132 chars/line

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	305,000
Transistors	201,000
Magnetic Cores	4,096,000

MADT transistors account for a very large percentage of those used.

Type WA diodes (an IBM classification) are used.

CHECKING FEATURES

100% single error detection with the capability of programmed error correction.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer, initial	106.66 Kw 164 KVA 0.65 pf
Power, computer, expand	203.42 Kw 312 KVA 0.65 pf
Power, air cond, expanded, liq	99.45 Kw
Power, air cond, expanded, air	23.80 Kw
Power, air cond, room	222.14 Kw
Volume, computer, initial	6,010 cu ft
Volume, computer, expanded	7,969 cu ft
Area, computer, initial	887 sq ft
Area, computer, expanded	1,161 sq ft
Area, comp, prog, initial	5,632 sq ft
Area, comp, prog, expanded	6,656 sq ft
Area, maint, tape, calibration	4,608 sq ft
Floor loading	150 lbs/sq ft
Weight, computer, initial	132,960 lbs, total
Weight, computer, expanded	181,560 lbs, total

Expanded Q-32 is with 18 tape drives and 10 storage units.

Site preparation requirements

Power equipment installation consisting of Power Distribution Unit, Frequency-Converters, and M-G sets for prime power regulation. Maintenance Room provisions for a-c regulators shall be installed.

Installation of Heat Exchanger for liquid cooling purposes.

Compressed air provision for drum units.

Segregated race-way systems (for signal and power) shall be provided for overhead at a height of 8'-8" and 9'-8" respectively.

Room air conditioning for personnel comfort.

Liquid cooling accommodations for transistorized equipment shall be provided.

Dais is desirable with access ramp and/or stairs due to underfloor cabling requirements for commercial equipment.

Leveling channels shall be installed for uniform floor loading for computer equipment.

Minimum 8 foot door heights have to be provided.

Power Emergency-Off system located within the building should be provided.

Lighting system for equipment installation and maintenance purposes (minimum average of 50 foot-candles illumination at floor level).

Adequate administrative office area must be provided.

PERSONNEL REQUIREMENTS

The personnel requirements are depended upon the intended application and requirements (reliability and shift policy) of the equipment as established by the user.

Training of operators, maintenance personnel, programmers and customer management is available on the basis of specific contract negotiation.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by the manufacturer to insure required reliability includes error detection hardware which enables 100% single failure detection and specific hardware in the machine, which is used for the FIX error correction concept, whereby an intermittant single error may be corrected by programming means. Specific hardware, connected with FIX, is used to isolate a solid failure to a minimum number of circuit elements (Q-PACS). Circuit design was accomplished utilizing an "End-of-life" technique. Marginal checking capability is provided to enable the operation of the system with marginal voltages. Marginal conditions may be controlled either manually or by program means. Diagnostic programming techniques are employed in conjunction with marginal checking to assist in locating circuit elements which have not yet failed but may be about to fail. Operating Experience - Prototype of system has been underlying reliability evaluation for approximately two years. No operating experience is available on the full system at this time. Good prototype reliability is reported.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a very sophisiticated instruction list. Machine design permits very efficient usage for either data processing tasks or scientific usage. The semi-variable field ability is not usually found with high speed arithmetic operations. Machine design permits use of many advanced programming techniques, i.e., direct or indirect adressing, single or double indexing, most internal registers are addressable. An ultra reliable design philosophy is utilized. System was designed primarily as a real time control system for a wide range of command control applications. In addition to a very powerful general purpose computer, the system has facilities for expansion (or contraction) in all storage and input/output areas to meet a large variety of real time control and computing demands. Error detection and correction design insures high reliability. The tape utilized on this system is from the standard IBM product line.

Anticipated installation date of first system is the fourth quarter of 1960.

The equipment described here may also be implemented as a completely duplexed installation with very effective communications link from one computer to the other. A modest product improvement program is planned.

AN/MJQ 1 REDSTONE

AN/MJQ 1 Missile Firing Data Computer (Redstone)

MANUFACTURER

North American Aviation
Autonetics Division

Photo by U. S. Army Ordnance Guided Missile School

APPLICATIONS

U. S. Army Ordnance Guided Missile School
Located in Room 114, Bldg. 3303, OGMS, Redstone Arsenal, Alabama, the primary mission of this system is to solve the Redstone Missile Firing Problem. The computer is currently being utilized to train students in Digital Computer Fundamentals.

U. S. Army Artillery and Missile School
Located in Bldg. 900, Gunnery/Cannon/Rocket Dept., Fort Sill, Oklahoma, the system is used for fire control computations.

STORAGE

USAOGMS and USAAMS

Medium	No. of Words	No. of Dig/Word	Access Microsec
Magnetic Disc	4,096	41	15,700

The disc is of beryllium.

INPUT

USAOGMS and USAAMS

Media	Speed
Keyboard (decimal)	Manual
Paper Tape (Teletype)	200 char/sec

Five channel tape is used.

OUTPUT

USAOGMS and USAAMS

Media	Speed
Typewriter (IBM)	9 dec dig/sec
Indicator (Nixie)	

Displays momentarily during printout. Readout capacity is 16 decimal digits, including sign.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

USAOGMS

Power, computer	0.4 Kw	0.9 pf
Weight, computer	155 lbs	

Complete system can be set on top of 2 office size desks. No special air conditioning or special installation requirements are needed.

USAAMS

Power, computer	1.3 KVA
Volume, computer	4.5 cu ft
Area, computer	3.4 sq ft
Floor loading	36.8 lbs/sq ft
Weight, computer	125 lbs

COST, PRICE AND RENTAL RATES

USAOGMS

System cost approximately $80,000.

A van, with air conditioning and power system for field use, cost approximately $80,000.

USAAMS

System cost $66,000.

PERSONNEL REQUIREMENTS

USAOGMS

The system is designed to be utilized in the field with a tactical organization and under tactical conditions. Its sole purpose is computation of the Redstone firing problem.

Personnel required for this system include only military operators and maintenance type personnel.

All training other than on-the-job training is conducted at the OGMS, Redstone Arsenal, Alabama.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USAOGMS

Figures are based on the period from Sep 58 to Apr 60.

Time is not available for rent to outside organizations.

This machine has approximately 1,000 hours of operating time on it. It is normally used for demonstrations and instructing students in maintenance and programming. A record exists only for the last 482 hours of operation. In this period 88.9 hours were utilized for maintenance. Of this maintenance time listed, many of the hours were spent adjusting and checking out memories for other machines before shipping them to overseas.

ADDITIONAL FEATURES AND REMARKS

USAOGMS

Outstanding features are simplicity of operation, and small size. Maintenance is difficult due to poor documentation and time sharing of components.

FUTURE PLANS

USAOGMS

There are apparently no future plans for this machine. In all probability the machine will be utilized for its present mission as is until the Redstone System is replaced with a newer system.

USAAMS

The Field Artillery Digital Automatic Computer (FADAC), a rugged, lightweight computer for use in the field with artillery units will replace this system.

INSTALLATIONS

U. S. Army Ordnance Guided Missile School
Redstone Section, BM Br., FAM Div.
Redstone Arsenal, Alabama

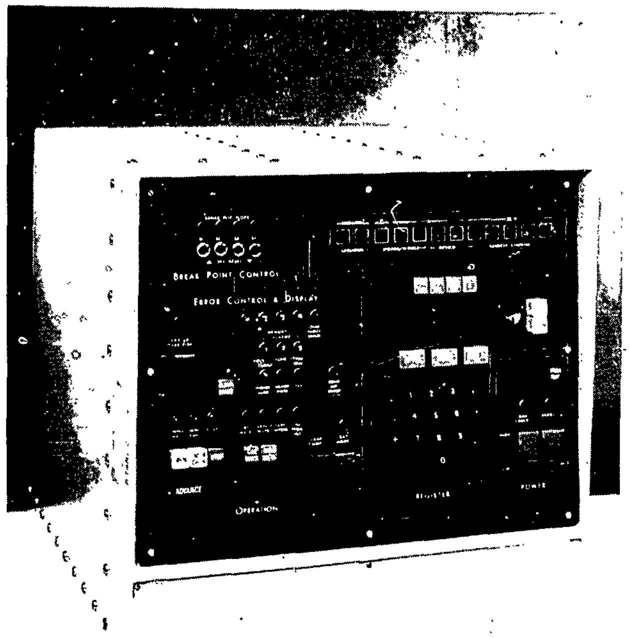
U. S. Army Artillery and Missile School
Computer Branch, R&R Div.
Fort Sill, Oklahoma

AN/TYK 4v COMPAC

COMPAC (AN/TYK-4v)

MANUFACTURER

Philco Corporation
Computer Division



COMPAC General Purpose Control Panel

Photo by USASRDL

APPLICATIONS

General purpose computer operating as an integral part of a larger weapon system; operation includes field artillery, fire direction, gun data computation and automatic transmission, survey data computation and automatic transmission, and meteorological data reduction, computation and automatic data transmission.

Major component of the Army automatic data processing system.

Major component of an automatic data processing system organized as an integrated subsystem.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number of binary digits per word	36 plus sign and parity
Number of binary digits per instruction	36 plus spare and parity
Number of instructions per word	1
Total number of instructions decoded	26 with in/out converter, 19 w/o in/out converter
Arithmetic system	Fixed point
Instruction type	One-address
Number range	$-(1-2^{-36})$ to $+(1-2^{-36})$

Instruction word format

Normal Command

Parity	Spare	Op. Code	Index Register	Minor Address	Major Address
38	37	36 31	30 28	27 16	15 1

I/O Command

Parity	Spare	Op. Code	Word Counter	Device Selection	Storage Address
38	37	36 31	30 22	21 16	15 1

Automatic coding COMPAC uses an assembly program

Registers and B-boxes
- Central processor 7 + 4 index = 11 registers
- In/Out converter 1

There are a total of 4 arithmetic, 4 transfer, 6 logical, 3 sense, and 9 input-output instructions. Of the input-output instructions, 7 require the I/O converter.

ARITHMETIC UNIT

Operation time	Inc. Stor. Access Microsec	Excl. Stor. Access Microsec
Addition	24	12
Multiplication	252	240
Division	252	240

Construction, arithmetic unit only	
Transistors	3,000
Condenser-Diodes	7,000
Arithmetic mode	Serial by 6 bits/char
Timing	Synchronous
Operation	Sequential

Mostly sequential, however, processing may proceed during input-output operations.

STORAGE

Media	Words	Digits/word	Microsec Access
Magnetic Core	4,096	38	12

Core storage up to 3 additional 4,096-word memories may be added.

Magnetic tape

Maximum number of units that can be connected to the system	8 Units
Maximum number of characters per linear inch of tape	300 Char/inch
Channels or tracks on the tape	16 Track/tape
Blank tape separating each record	1-1.5 Inches
Tape speed	1 to 150 Inches/sec
Transfer rate	300 to 45,000 Char/sec
Start time	3 Millisec
Stop time	3 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	1 Inch
Length of reel	3,600 Feet
Composition	Mylar

Two tracks on magnetic tape are "guard" channels and are not usable.

INPUT

Media	Speed
Paper tape reader memory loader	30 char/sec or 300 char/sec
Keyboard on console	Manual entry speed

OUTPUT

Media	Speed
Paper tape punch/printer	30 char/sec
Communications converter Limited by programming	45 KC

Input/Output Device can be added. This enables use of:
- Paper tape reader
- Paper tape punch
- Tape transports
- 120 char line printer
- 24 char line printer
- FIELDATA typewriter

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
IN-643	3,500
Transistors	
2N706	10,000
Magnetic Cores	156,000
Memory	

CHECKING FEATURES

Parity on memory transfer and input/output; overflow; non-existent memory; non-existent instruction; non-existent device (I/O); marginal checking.
Diagnostic Program.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Volt-Amperes, computer	4 KVA
Space, computer	9 cu. ft.
Weight, computer	200 lbs.

COMPAC has no special requirements. It can be used in the field, on trucks, or in rooms.

PRODUCTION RECORD

Number produced to date	0
Number on order	1
Time required for delivery from receipt of order	12 months

PERSONNEL REQUIREMENTS

Estimated	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	2	3
Programmers and Coders			
Operators	1-2	2-4	3-6
Technicians	1	2	3

The number of coders and programmers depends on applications.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The estimated mean time between failures is 101 hours for the COMPAC Central Processor.

ADDITIONAL FEATURES AND REMARKS

Ruggedized for field use, operating from 25°F to +125°F; 0 to 97% relative humidity.

Computer can be expanded into a system with additional memories, input-output converters and communications converters.

It is a member of the Army FIELDATA family of computers. It uses the FIELDATA code and is compatible with other FIELDATA machines.

System uses a communications converter. Operating at 45 Kc, it is limited by programming.

INSTALLATIONS

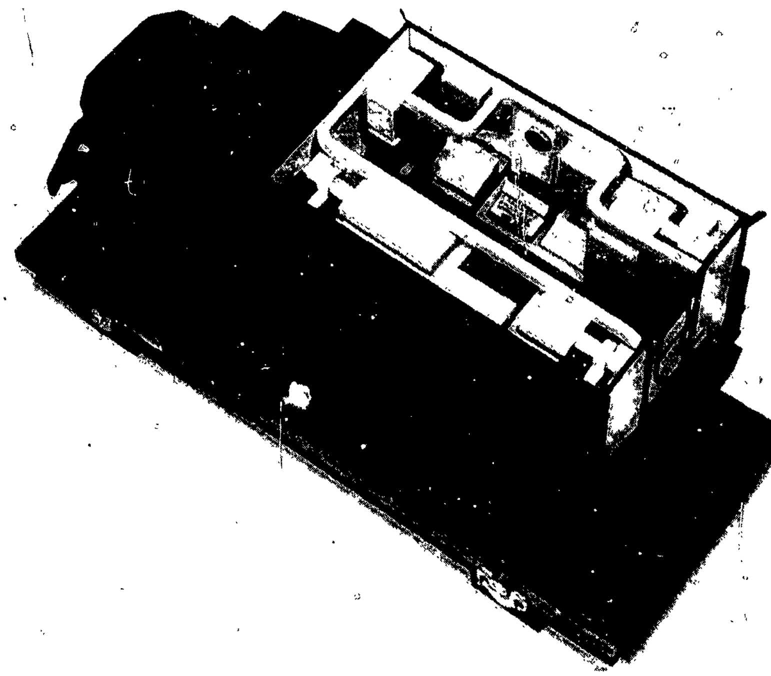
Mobile with the Army in the field.

AN/TYK 6v BASICPAC

BASICPAC (AN/TYK-6v)

MANUFACTURER

Philco Corporation
Compute: ; 'ision



Typical Basicpac Computer Arrangement

Photo by USASRDL

APPLICATIONS

Manufacturer
The system is designed for military field use including a variety of logistical, administrative, intelligence, command control, fire support, and miscellaneous activities.
Fairchild Astrionics - Primarily for drone recovery.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number of binary digits per word	36 plus sign and parity
Number of binary digits per instruction	36 plus spare and parity
Number of instructions per word	1
Total number of instructions decoded	41
Arithmetic system	Fixed point
Instruction type	One-address
Number range	$-(1-2^{-36})$ to $+ (1-2^{-36})$

Instruction word format

Standard Computer Instruction Word

38	37	36 31	30 28	27 16	15 13 12 1
Parity	Spare	Op. Code	Index Reg. Selection	Minor Address	Major Address

Input-Output Instruction Word

38	37	36 31	30 22	21 16	15 13 12 1
Parity	Spare	In-Out Command	Word-Block Counter	Device Selection	Storage Address

Automatic coding BASICPAC uses an assembly program
Registers and B-boxes
Central processor 6 + 4 index = 10 registers
Communications converter 10
In/Out converter 6

There are a total of 8 arithmetic, 7 transfer, 13 logical, 3 sense, and 10 input/output instructions. Of the input/output instructions, 5 require the I/O converter, and one requires the search unit.

The index registers may be increased to a total of 7.

BASICPAC central processor consists of one 4,096 word memory, arithmetic, programming and control units. BASICPAC system may contain one to seven input-output converters, and one communications converter. Each Input/Output converter can handle up to eight I/O devices.

ARITHMETIC UNIT

Operation time, including storage access, microseconds

Addition	22 - 26
Miltiplication	238 - 242
Division	238 - 242

Construction, arithmetic unit only

Transistors	14,000

Arithmetic mode	Serial-parallel 6 bits/char
	Parallel by bits
	Serial by character
Timing	Synchronous
Operation	Sequential

Mostly sequential, however, processing may proceed during input/output operations.

STORAGE

Media	Words	Digits/word	Microsec Access
Magnetic Core	4,096	38	12

Core storage up to 6 additional 4,096-word memories may be added.

Magnetic Tape

Maximum number of units that can be connected to the system	56 Units
Maximum number of characters per linear inch of tape	300 Char/in.
Channels or tracks on the tape	16 Track/tape
Blank tape separating each record	1-1 1/2 Inches
Tape speed	1 to 150 Inches/sec
Transfer rate	300 to 45,000 Char/sec
Start time	3 Millisec
Stop time	3 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	1 Inch
Length of reel	3,600 Feet
Composition	Mylar

This system employs the FIELDATA Tape Transport.

These units are connected to the central processor through the I/O converter.

Two tracks on Mag tape are "guard" channels and are not usable.

INPUT

Media	Speed
Paper Tape Reader	30 Char/second
Communications Converter	Approx. 45 KC, rate

Handles up to 8 simultaneous real time input channels

Keyboard on control panel	Manual entry speeds
Mag Tape Transport	45 KC

Communications converter rates limited by programming.

OUTPUT

Media	Speed
Paper Tape Punch	20 Char/second
FIELDATA Typewriter	100 words/min
Page printer	

Must be operated with I/O converter

Communications converter	Approx. 45 KC rate

Handles up to 8 simultaneous real time output channels

Nixie display

Under program control or operator control

Mag tape	45 KC

COST, PRICE AND RENTAL RATES

Fairchild Astrionics $1,000,000 for 2 complete units.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type No.	Quantity
Diodes	
SG22	750
IN270	200
Transistors	
2N-393	13,500
2N-599	240
2N-341	162
2N-1123	174
2N-501-A	112
Magnetic Cores Memory	156,000

CHECKING FEATURES

Parity on memory transfer and input/output; overflow; non-existant instruction; non-existant memory; non-existant devices (I/O); marginal checking.

Diagnostic Programs.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Volt-Amperes, computing system	22 KVA
Space, central processor	25 cu. ft.
Space, system	500.68 cu. ft.
Area, system	80.10 sq. ft.
Room size, system	S-109 shelter
Air conditioners, two	9,000 BTU/hr, each
Weight, total system, incl air conditioners	4,150 lbs.

BASICPAC system is housed in a S-109 shelter (75 inches high, 79 inches wide, and 146 inches long). Air conditioning is for operator comfort only.

PRODUCTION RECORD

Number in current production	2	Produced	5
Number on order	2	Operation	3
Time required for delivery from receipt of order	12 months		

PERSONNEL REQUIREMENTS

Estimated	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	2	3
Programmers and Coders	2		
Operators	1-2	2-4	3-6
Technicians	1	2	3

The number of coders and programmers depends on applications.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Estimated mean time between failures:

154 hours for BASICPAC system.

209 hours for BASICPAC central processor.

ADDITIONAL FEATURES AND REMARKS

Ruggedized for field use. Will operate from -25°F to +125°F; 0 to 97% relative humidity.

The system is expansible in that 1 to 6 additional memories may be added, and 1 to 56 I/O devices may be added.

This machine is a member of the Army FIELDATA family of computers. It uses the FIELDATA code and is compatible with other FIELDATA machines.

INSTALLATIONS

Mobile with the Army in the field.

Fairchild Astrionics Division, Wyandanch, N. Y.

AN/TYK 7v INFORMER MANUFACTURER

Minimal Informer (AN/TYK-7v)

International Business Machines Corporation

APPLICATIONS

System is designed for military field use, including a variety of applications, such as Intelligence, Logistics, and Personnel.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36 plus sign and parity
Binary digits/instruction	36 plus spare and parity
Instructions per word	1
Instructions decoded	55
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-(1 - 2^{-36})$ to $+(1 - 2^{-36})$

Instruction word format (Operation)

38	37	36 31	30 28	27 16	15 1
Parity	Spare	Operation Code	Index Register Selection	Index Increment	Memory Address

(Input-Output)

38	37	36 31	30 22	21 16	15 1
Parity	Spare	I/O Code	Word or Block Count	Device Addr.	Storage Addr.

Registers and B-boxes

In the central processor there is a total of 10 registers, viz, A Q, Program Counter, Program Counter Store, X, Y, and 4 Index Registers. There is one Input/Output converter instruction register.

The system utilizes a total of 17 arithmetic instructions, 8 transfer, 17 logical, 3 sense, and 10 input-output instructions.

Mobidic Assembly Program may be used.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	20.7	12.7
Mult	392	376
Div	425	400

Construction (Arithmetic unit only)

	Type	Quantity
Transistors	2N696	3,204
Magnetic Cores	4 maxwell	5,799

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

System operates primarily sequentially, however processing may proceed during input-output operations.

CHECKING FEATURES

Checking features used are parity on memory transfer and input/output, overflow, non-existant instructions, non-existant memory, non-existant devices (I/O), and marginal checking. Diagnostic programs are available.

STORAGE

Media	No. of Words	No. of Digits/Word	Microsec
Core	4,096	38	8
Disk File	3,750,000	38	150,000

Additional Core Storage may be added up to 6 more 4,096 memories.

Magnetic Tape

No. of units that can be connected	16 Units
No. of characters/linear inch	300 Chars/inch
Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	1-1.5 Inches
Tape speed	1-150 Inches/sec
Transfer rate	300 to 45K Chars/sec
Start time	3 Millisec
Stop time	3 Millisec
Average time for experienced operator to change reel	30 Seconds
Physical properties of tape	
Width	1 Inch
Length of reel	3,600 Feet
Composition	Mylar

Two tracks on magnetic tape are "guard" channels and are not useable.

INPUT

Media	Speed
Magnetic Tape	45,000 char/sec
Disk File	69,000 char/sec
Paper Tape	30 char/sec
Console	Manual entry speed

OUTPUT

Media	Speed
Paper Tape Punch	20 char/sec
FIELDATA Typewriter	100 words/min
Magnetic Tape	45,000 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Use
Diodes	6,314	Switching Units
Transistors	10,789	Power Amplification
2N696		
2N697		
2N1253		
Magnetic Cores		
Tape	10,861	Logical Elements
Ferrite	163,840	Core Storage

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	2	3
Programmers	1		
Coders	1		
Operators	1-2	2-4	3-6
Technicians	1	2	3

Number of programmers and coders depends on application.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.312 Kw	0.445 KVA 0.7 pf
Volume, computer		21.0 cu ft
Area, computer		4.1 sq ft
Room Size		S-109 shelter
Floor loading		110 lbs/sq ft
		440 lbs concen max
Weight, computer		440 lbs
Weight, air conditioner		158 lbs
Capacity, air conditioner		3/4 Ton

System is installed in S-109 shelter. Air conditioning is for operator comfort only.

PRODUCTION RECORD

Number in current production	1
Number on order	1
Time required for delivery	18 months

ADDITIONAL FEATURES AND REMARKS

System is ruggedized for field use, will operate from -25°F to +125°F, 0 - 97% relative humidity, and has the ability to select desired information from files without "knowing" the exact location of the information. Pulse Magnetic Logic is used. This machine is a member of Army FIELDATA family of computers. It uses the FIELDATA code and is compatible with the FIELDATA machines.

INSTALLATIONS

International Business Machines Corporation
Neighborhood Road
Kingston, New York

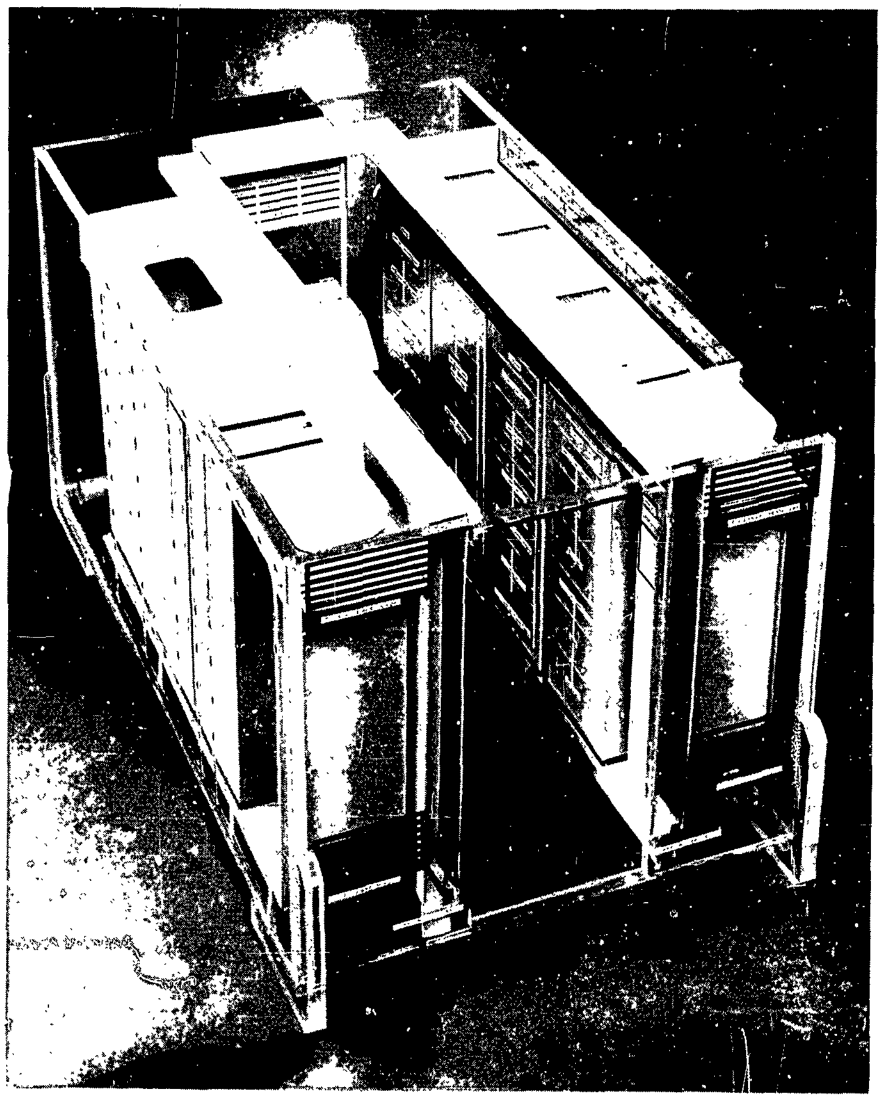


Photo by International Business Machines Corporation

AN/USQ 20

AN/USQ 20 Navy Tactical Computer

MANUFACTURER

Remington Rand Univac
Division Sperry Rand Corporation
Univac Park
St. Paul 16, Minnesota

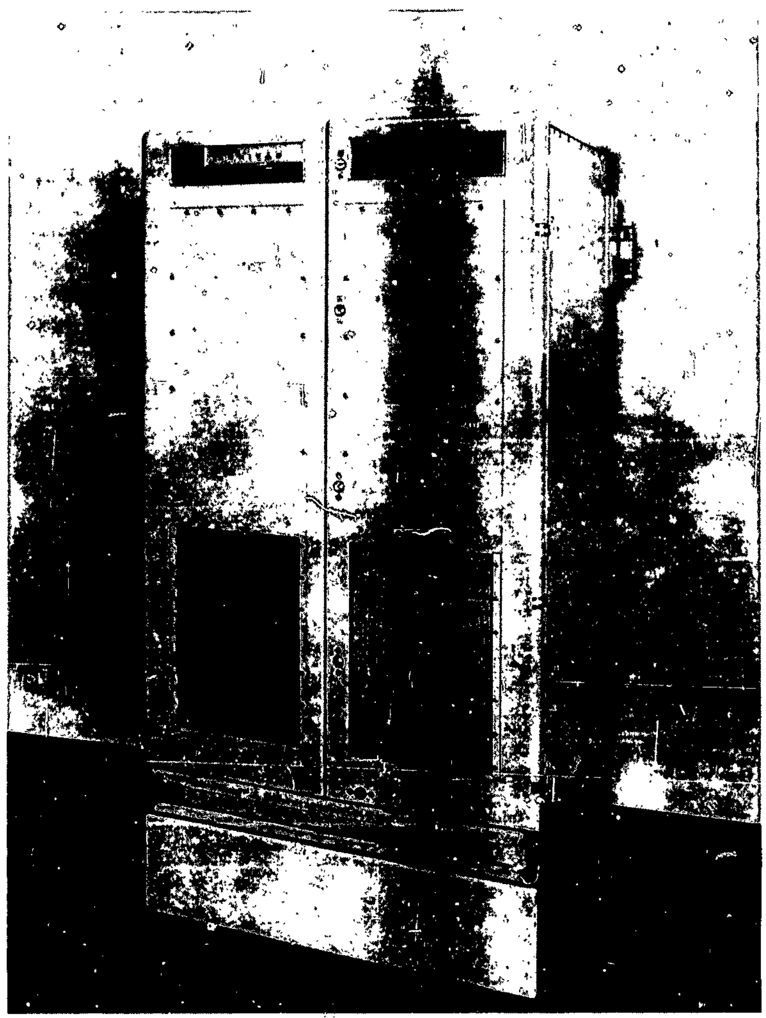


Photo by Remington Rand Univac

APPLICATIONS

Designed as a Navy tactical data system computer, it is used for scientific, general purpose, data processing, on or off-line.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	30
Binary digits/instruction	30
Instructions per word	1

Arithmetic system	Fixed point
Instruction type	One address
Instruction word format	

F Function Code	J Branch Cond. Des.	K Operand Interp. Des.	B Index Designator	Y Operand Designator (The operand or the address of the operand destination
6-bits	3-bits	3-bits	3-bits	15 bits

Automatic built-in subroutines includes automatic recovery.

A compiler is available.

Registers and B-boxes include A - 30 bit addressable accumulator, Q - 30-bit addressable logical function register, and B^1 - B^7 - seven (7) 15-bit index registers (B-boxes).

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	16	9.6
Mult	35.2 - 112	35.2 - 112
Div	112	112

Construction (Arithmetic unit only)	
Transistors	1,900
Diodes	5,700
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Cycle Time Microsec
Magnetic Core	32,768	30	8
Plugboard	16	30	8

INPUT

Media

Keyboard (Flexowriter)

Paper Tape

Magnetic Tape

On-line analog to digital converters

Specifications not yet finalized.

OUTPUT

Media

Hi-Speed Printer

Typewriter (Flexowriter)

Paper Tape

Magnetic Tape

On-line digital to analog converters

Specifications not yet finalized.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	33,787
Transistors	10,265
Magnetic Cores	983,040

For 32,768 30-bit words.

CHECKING FEATURES

All program checked (No internal checking).

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	2.5 Kw	3.1 KVA	0.8 pf
Power, air condit	2.0 Kw	2.2 KVA	0.9 pf
Volume, computer		60 cu ft	
Area, computer		27 sq ft	
Weight, computer		2,320 lbs	

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

PERSONNEL REQUIREMENTS

Training made available by the manufacturer to the user includes written publications on description, theory, operation and maintenance. Orientation courses, conducted by Training Department, Field Service staff personnel, will be given to assist in maintenance of computers at site.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include real time clock, automatic recovery, repeat mode, extremely versatile input-output logical function capabilities, and wide environmental limits.

Unique system advantages include large hi-speed core memory, versatile instruction repertoire, hi-computing speed (less than 14 microseconds per instruction, average), and asynchronous type of operation.

INSTALLATIONS

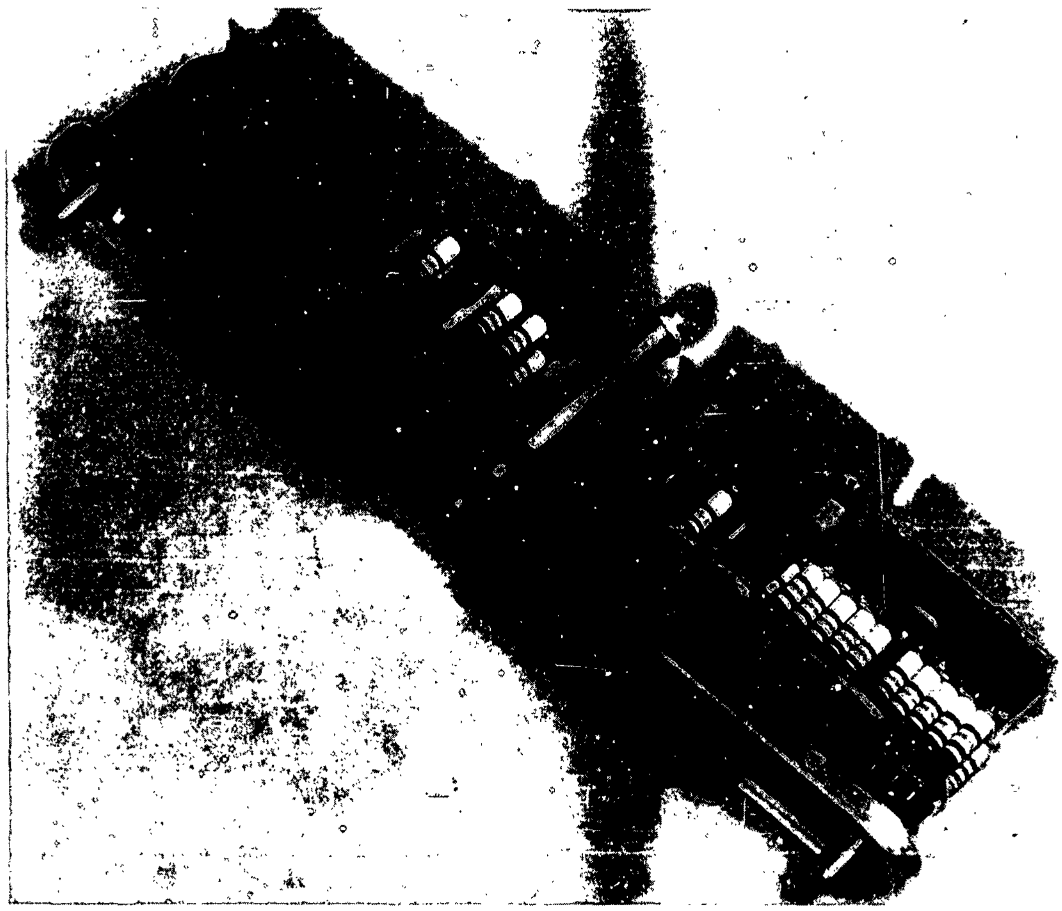
Remington Rand Univac
Division of Sperry Rand Corporation
Univac Park
St. Paul 16, Minnesota

ASC 15

Advance System Controller Model 15

MANUFACTURER

International Business Machines Corporation
Federal Systems Division



Welded Encapsulated Module

Photo by International Business Machines Corporation, Federal Systems Division

APPLICATIONS

Computer is used in airborne guidance and control systems and is capable of a number of guidance system monitoring and check-out functions (ground operations). System is similar to the computer being developed by IBM for use in the Titan Guidance Subsystem.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	27
Binary digits/instruction	9
Instructions per word	3
Instructions decoded	22
Arithmetic system	Fixed point
Instruction type	Two address (modified)
Number range	2^{24}

Instruction word format

A computer instruction consists of the following nine bits: FFFFF, TTTT. Every operation can be considered a transfer of the contents of the F (from) address to a location specified by the T (to) address memory.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	312	156
Mult	2,028	1,872

High speed Mesa transistors are used in the arithmetic unit.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

There are two independent arithmetic elements (Adder and Multiplier). Addition and multiplication can be performed simultaneously.

STORAGE

Medium	No. of Words	No. of Bits	Access Microsec
Magnetic Drum	3,840	99,584	5,000

Thin Shell Magnetic Drum - Air-floated read-write heads.

INPUT

Media	Speed
Optisyns (hi-speed)	6,400 positive increments/sec 3,200 negative increments/sec (Accelerometer and attitude)
Optisyns (lo-speed)	100 increments/sec (real-time)
Discrete Inputs	As programmed (740 in number)

OUTPUT

Media	Speed
3 Ladder	As programmed (± 6 volts 64 increments)
12 Discrete	As programmed
1 Digital	5 bit parallel

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

High speed Mesa transistors are used.

CHECKING FEATURES

There is a built-in check to determine whether computer is out of synchronization.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.150 Kw
Volume, computer	Between 2 and 3 cu ft

A fan provides 100 cu ft/min of air at a pressure rise of 2" water above atmospheric pressure.

Weight, computer	Under 100 lbs

Computer logic is packaged in welded encapsulated modules.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System is designed for a mean time to failure of 1,000 hours.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include welded encapsulated module packaging, built to conform to missile environmental specifications, dual arithmetic units, and high reliability (MTF greater than 1,000 hours).

Unique system advantages include minimal addressing, which requires only 9 bits per instruction, and a number of system monitoring and control functions.

ATHENA

ATHENA

MANUFACTURER

Remington Rand Univac
Division of Sperry-Rand Corporation

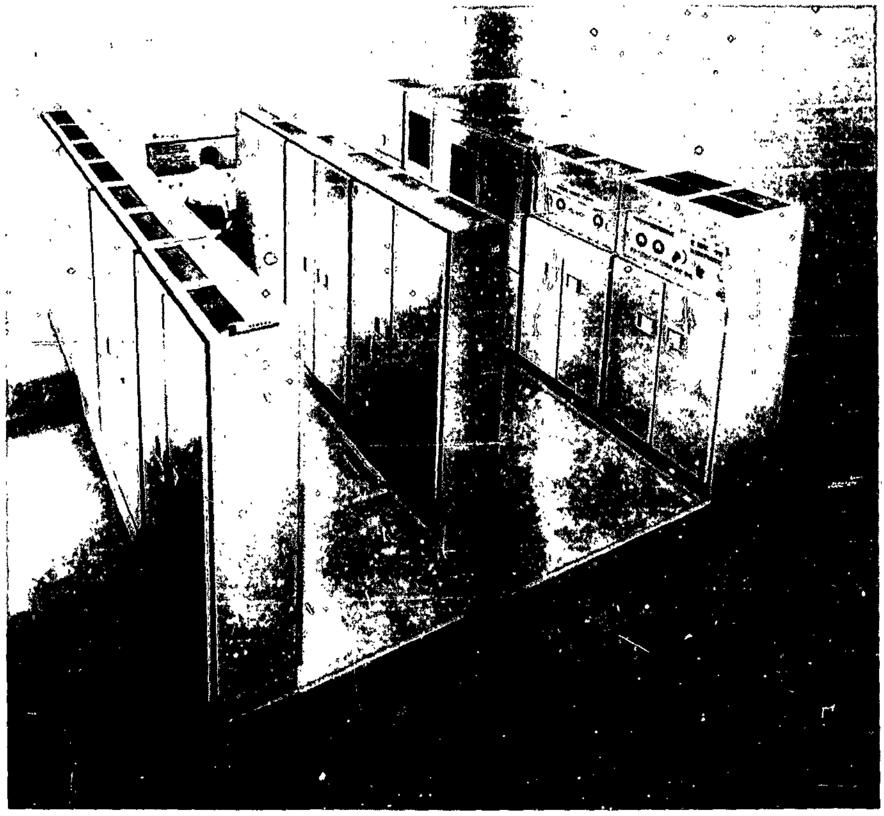


Photo by Remington Rand Univac
Division of Sperry-Rand Corporation

APPLICATIONS

Primary application is as a missile guidance computer. It is a special purpose, on-line machine that runs synchronized with the guidance system.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/ word	24
Binary digits/instruction	17
Instructions per word	1
Instructions decoded	34
Arithmetic system	Fixed point (fractional)
Instruction type	One address

Data Registers
- Accumulator
- Quotient
- Exchange
- Steering
- Acceleration
- Discrete
- Display

Control Registers
- Tape Assembly
- Drum Transfer
- Program Control
- Program Address
- Tape Disassembly

Input Data Control
Input Constants Control

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	40
Mult	520
Div	1,000

Construction (Arithmetic unit only)

Transistors	800
Diodes	4,000
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Bin Digits/Word	Access Microsec
Magnetic Drum	8,192	17	
Magnetic Core	256	24	40

Magnetic Tape

No. of units that can be connected	1 Unit
No. of chars/linear inch of tape	200 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	24 Inches/sec
Transfer rate	4,800 Chars/sec
Start time	3,000 Millisec
Stop time	3,000 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Mylar

The magnetic drum contents cannot be altered by a program instruction.

The magnetic tape unit is a system monitor only.

INPUT

Medium

Paper Tape

Reader can introduce information to the magnetic drum or the simulator.

OUTPUT

Media

Magnetic Tape

Tape unit can record computational results along with input data.

Paper Tape

Punch can record program information from magnetic drum or core storage.

Printer

Printer can record 8 decimal or octal digits.

The simulator is a combination input-output device used to check computer operation.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	33,000
Transistors	7,500
Magnetic Cores	7,680

CHECKING FEATURES

Checking features include add, divide and shift overflow invalid instruction. Checking may optionally be performed by a simulator.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	5.5 Kw	10 KVA	0.55 pf
Volume, computer		2,860 cu ft	
Area, computer		370 sq ft	
Room size		36 ft x 24 ft	
Capacity, air conditioner		5 Tons	
Weight, computer		21,000 lbs	

Power requirement based on actual measurement.

PERSONNEL REQUIREMENTS

Written publications on description, theory, operation and maintenance; orientation courses conducted by training department; staff of the manufacturer's field service personnel assist in maintenance of the computer on site.

ADDITIONAL FEATURES AND REMARKS

The outstanding feature is reliability.

BENDIX CUBIC TRACKER

BENDIX G-15D and MTA-2 p/o AN/GSQ-29(xl-1)

MANUFACTURER

Computer Division
Bendix Aviation Corporation
and
Cubic Corporation

APPLICATIONS

Systems are located at Tyndall Air Force Base, Cape San Blas, and Carabelle, Florida. Tracking Stations at Cape San Blas and Carabelle develop direction cosines measured from x & y base lines for up to three targets, and a frequency correction word for each target transmitter. Information is transmitted via data link to computing site at Tyndall. Data words are automatically converted to G-15D word length and written directly on computer drum. Program converts direction cosine information to (x,y,z) position and controls automatic position plot of two of the three targets. A command word is generated at the computer site to instruct the program which target trajectories to plot, the change being controlled by transmission of a release signal from one target (interceptor) and a burst signal from a second target (missile). Burst also causes the program to compute the vector miss distance from the 3rd target (drone) to the missile in the velocity vector coordinate system of the drone, and the scalar escape distance between the missile and the interceptor in the MATTS (AN/GSQ-29) coordinate system. Program modifications also permit computation of x, y, z coordinates of any or all targets either on a sample by sample basis (basic sample rate is 20/sec) in non-real time, or at a rate of approximately one sample/sec either real or non-real time.

Though the system was basically designed for scoring air-to-air missile firings it has also been successfully used to track missiles fired from the ground.

Modifications made to the G-15D to permit on-line data processing were accomplished so as to also permit general purpose use of the computer. Part of the high speed punch facility was utilized for an additional long memory line for format conversion and automatic data entry, and the DA-2 circuitry was modified in a minor way to permit data to be written on the M16 and M17 long lines separately.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Computer Drum long line	108	3,132	19,500 avg
Computer Drum 4 wd. line	4	116	504 avg
Computer Drum 2 wd. line	2	58	270 avg
Computer Drum 1 wd. line	1	1	270

INPUT

Media	Speed
Photo Tape Reader	200 hex char/sec
MTA-2 (Bendix)	427 hex char/sec
300,000 words/unit max. of 4 units	
IBM Typewriter Modified Manual	
Matts Buffer & Input Register	

Buffer "reads" incoming data at rate of 20 samples/sec max, stores twelve 19 bit cosine words and six 10 bit calibrate words at 3kc bit rate, "write" data onto computer drum at 110kc clock rate under automatic control of computer and converts words into computer word length of 29 bits. Maximum time between end of "read" and start of "write" 19,500 microsec. (1/2 drum rev). Write time = 4860 microsec (18 word times), Input register automatically reads one word onto computer Early Buss under program control. Maximum access time is 4 wt (1,080 microsec including ready test.

OUTPUT

Media	Speed
Photo Tape Punch	17 hex char/sec
MTA-2	427 hex char/sec Max. of 4 units
IBM Typewriter	8 hex char/sec
Output Register	270 microsec/word Under program control

Minimum program time for (x, y, z) plot of two targets via output register is 16 word times (4320 microsec) including transfer from storage and transfer to output register. Output register operates automatically under computer control.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	4.3 Kw	4.5 KVA	0.95 pf
Power, air conditioner	6 Kw	7.5 KVA	0.80 pf
Volume, computer	60 cu ft		
Volume, MTA-2	30 cu ft		
Volume, MATTS System	130 cu ft		
Volume, air conditioner	192 cu ft		
Area, computer	10 sq ft		
Area, MTA-2	6 sq ft		
Area, MATTS System	18 sq ft		
Area, air conditioner	24 sq ft		
Room size, system	Van 30 x 8 x 7.5 ft		
Room size, air conditioner	4 x 6 x 8 ft		
Floor loading, system	45 lbs/sq ft		
Weight, computer	450 lbs		
Capacity, air conditioner	6 Tons		

Parking pad is approximately 30 x 10 ft
Power is 220 v, 60 cycle, 3-wire, 80 amps.

COST, PRICE AND RENTAL RATES

Components distribution

Computer Site
(1) Data Handling
(2) Data Link (GFE)
(3) Tape Recorders
(4) Computer and Typewriter
(5) MTA-2
(6) D/A Converters (3 ea)
(7) Plotting Boards (2 ea)

Tracking Sites
(1) Tracking System
(2) Data Handling
(3) Tape Recorders (2 ea/site)
(4) Data Link (GFE)

Airborne Transmitters
(1) Interceptor
(2) Target
(3) Missile

Maintenance available on system through Cubic Corp. Maintenance available on computer through Bendix Computer Division.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift Used	One 8-Hour Shift Recom	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recom	Three 8-Hour Shifts Used	Three 8-Hour Shifts Recom
Supervisors-Programmers	1	1	1	1	1	1
Engineer-Operator	3	4	3	8	0	12

Operation tends toward open shop.

Methods of training used includes formal classroom plus on-the-job training under qualified personnel, teaching operation and maintenance. Customer personnel (USAF), includes 1 Supervisor, 2 Programmers (Computer Operators) and 10 Technicians.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period 40 Hours
Good time 12 Hours/Week (Average)
Attempted to run time 12.1 Hours/Week (Average)
Operating Ratio (Good/Attempted to run time) 0.99
Above figures based on periodl Mar 60 to 1 Aug 60
Date this system passed customer acceptance test: undergoing acceptance tests.

Time is probably available to other AF organizations on an availability basis.

ADDITIONAL FEATURES AND REMARKS

System utilizes GP computer for special purpose application yet permits utilization of computer for GP applications by merely rotating a switch.

System measures spatial position to 50 parts/million, less than 40 ft. error in vector miss distance.

Special purpose system utilizing GP computer system designed for scoring air-to-air missile firing, with latitude in design to permit modification to other related applications.

FUTURE PLANS

Replacement of electro-mechanical servo system and data handling system at tracking sites with Cubic Electronic Digital Phase Meters.

INSTALLATIONS

System distributed between Tyndall AFB, Cape San Blas, and Carabelle, Florida.

BENDIX D12

Bendix D12 Digital Differential Analyzer

MANUFACTURER

Bendix Computer Division of Bendix Aviation Corp.

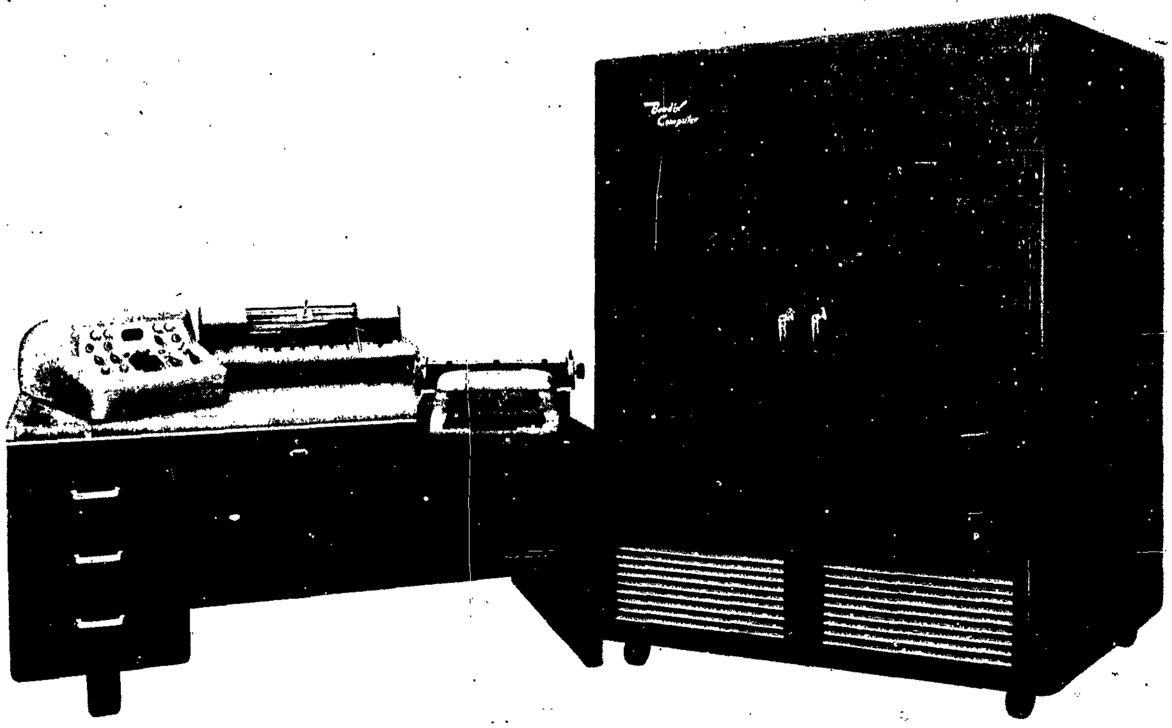


Photo by Griffiss Air Force Base

APPLICATIONS

Manufacturer

Solution of differential equations.

Statistical Services Div., Hq RADC, Griffiss AFB

The system is used for the solution of scientific problems, involving differential-integral equations (orbits, trajectories, Bessel functions, etc).

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	8
Arithmetic system	Fixed point
Number range	-5.0000000 to +4.9999999

As this system is a digital differential analyzer, usual digital computer instructions are not used. The computer employs a semi-fixed program.

ARITHMETIC UNIT

		Microsec
Add time (exclud stor access)		43
Construction	Vacuum tubes	
Basic pulse repetition rate	200 Kc/sec	
Arithmetic mode	Serial	
Timing	Synchronous	
Operation	Sequential	

Decimal digits are treated serially, whereas their binary codes are held in parallel.

STORAGE

Manufacturer

Media	Words	Binary Digits
Magnetic Drum	650	22,000

Access times are not relevant because of the fixed program.

Griffiss AFB

Media	Words	Binary Digits
Magnetic Drum	240	8 plus sign

This system has 60 integrators.

INPUT

Manufacturer

Media	Speed
Paper Tape	6 dig/sec

Griffiss AFB

Media	Speed	
Paper Tape	6 dig/sec	
Typewriter Keyboard	Manual	
Curve Follower (Attachment)	20 dig/sec	(Imperical Input)

OUTPUT

Manufacturer

Media	Speed
Typewriter	10 dig/sec
Graph Plotter	20 dig/sec, 100 steps/inch

Griffiss AFB

Typewriter (IBM)	10 dig/sec
Paper Tape	10 dig/sec
Graph Plotter	20 dig/sec, 100 steps/inch

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	700
Tube types	6
Crystal diodes	2,200
Separate cabinets	2

CHECKING FEATURES

Overflow in addition
Prescribed code as a result of addition

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	7.5 Kw
Power, air conditioner	105 cu ft 25 sq ft
Weight, computer	2,000 lbs

A desk is provided in addition to the computer console proper.

Griffiss AFB

Power, computer	7.5 Kw
Volume, computer	125 cu ft
Area, computer	42.5 sq ft
Room size, computer	400 sq ft

Located on false floor. Air conditioner is shared with other equipment.

PRODUCTION RECORD

Manufacturer

The Bendix D-12 is no longer in production and is manufactured only when a customer's needs can not be met by any other equipment. The DA-1 used with the G-15D General Purpose Computer System is based on the D-12 and uses the memory of the G-15D for combined GPC and DDA operation. The DA-1, while low-priced, is therefore equipped with 108 integrators and 108 constant multipliers.

COST, PRICE AND RENTAL RATES

Manufacturer

Approximate cost of basic system $55,000, including one graph plotter unit.
Approximate cost of additional equipment $8,035 for unit for interconnecting two computers.

Griffiss AFB

The basic computer cost $48,000.
The extra coding unit, graph plotters and curve follower cost $20,000.

PERSONNEL REQUIREMENTS

Griffiss AFB

System requires one engineer and 1 operator.
Operation tends toward closed shop. Method of training includes the use of maintenance manuals and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Good time	500 Hours
Attempted to run time	600 Hours
Operating ratio (Good/Attempted to run time)	0.83
Passed Customer Acceptance Test	1 Aug 54

Griffiss AFB

Average error-free running period	40 Hours
Good time	1,000 Hours

Above figures based on period 15 Mar 56 to 1 Nov 56.
Passed Customer Acceptance Test 15 Mar 56

ADDITIONAL FEATURES AND REMARKS

Manufacturer

The system is unusually easy to code and operate, since it is a fixed code machine.

INSTALLATIONS

Products Division
Bendix Aviation Corporation
Mishawaka, Indiana

Wright Air Development Center
Wright-Patterson Air Force Base
Dayton, Ohio

Redstone Arsenal
Huntsville, Alabama

Lockheed Aircraft Company
Marietta, Georgia

Griffiss Air Force Base
Rome, New York

BENDIX G15

Bendix G15

MANUFACTURER

Bendix Corporation
Bendix Computer Division

Photo by North American Aviation, Inc.

APPLICATIONS

Manufacturer
General purpose and scientific computing.

U. S. A. Artillery & Missile School, Ft. Sill
Located in Bldg. 900, Gunnery/Cannon/Rocket Dept., Fort Sill, Oklahoma, the system is used for cannon and rocket research studies.

U. S. A. Command and General Staff College
Located in Room 345, Bell Hall, USACGSC, the system is used for curve fit analysis of nuclear data for instructional and operational purposes, various conversion tables, and production of data for tables of precomputed nuclear target analyses (Weapon Selection Tables).

U. S. A. Engineer District, Little Rock
Located at 300 Broadway, Little Rock, Arkansas, the system is used for reservoir and flood routing, earthwork quantities for embankments and highways, stability analysis for dams and walls, traverse closure in surveys, moment distribution, reinforced concrete design - cantilever wall, and pile foundation design.

U. S. A. Engineer District, Los Angeles
Located at the Los Angeles District Office, the system is used for engineering computations in the fields of surveying, soils, hydrology, hydraulics, structural design and miscellaneous engineering applications.

U. S. A. Map Service, Americas Division
Located at Army Map Service, Americas Division, 6500 Brooks Lane, Washington 25, D. C., the system is used for geodetic, astronomic, and photogrammetric computations.

U. S. A. Ord. Frankford Arsenal - ORDBA-6230
Located at Frankford Arsenal Bldg. 220-1st floor, the system is used for optical design - 95%, and miscellaneous technical - 5%.

U. S. A. Ordnance Mission, White Sands Missile Range
Located at the Structures Branch, the system is used for calculation of structural response, stress analysis calculations in structural members, processing of structural data collected from missile range firings, processing of structural data collected from laboratory tests of structural items, calculations involving simulations of missile systems, and research

Photo by Naval Supersonic Laboratory, MIT

into transient loading at missile structures. This computer is to be used to reduce the engineering time required for structural analyses calculations resulting from measurements collected during missile range operations and structural laboratory testing.

U. S. A. Snow Ice Permafrost Research Establishment
Located at 1215 Washington Ave., Wilmette, Illinois, the system is used for engineering analysis.

U. S. N. Air Development Center
Located at the Aeronautical Computer Laboratory, Johnsville, Pa., the system is used for scientific computations and scientific data processing.

U. S. N. Bureau of Weapons
Located in Temporary "W" Bldg., Room 2W91, 18th & Constitution Avenue, N. W., Washington, D. C. the system is used for the solution of scientific problems only.

U. S. N. Charleston Shipyard
Located at the Design Division, Planning Department, the system is used for polemast stress analyses, longitudinal strength calculations, transverse strength calculations, shear and moment curves for simply supported beams, A.C. power analysis, A.C. lighting analysis, angle-arc analysis, list and stability calculations, natural frequency of resilient mounts, inclining experiments, weight and moment calculations, lighting system fixtures analysis, moment distributions, star tracker, trochoidal wave, curve expansions, and properties of simply supported beams.

U. S. N. Engineering Experiment Station Annapolis
Located in Building 113 the system is used for noise spectrum analysis, magnetic fields-data reduction and statistical analysis, bearings computations, harmonic tables computation, thermoconductivity-regression analysis, "one-shot" type engineering problems, and training of station personnel.

U. S. N. Hydrographic Office, Suitland
Located at the Geodetic Computing Unit, Survey Branch, Chart Construction Division, system is used for position determination, triangulation computations, electronic aids to navigation computations, statistical studies, astro and azimuth computations and distance computations.

U. S. N. Mine Defense Laboratory
System is used as an on line computer in a navigation system to provide positional data on a real time basis.

U. S. N. Missile Center Point Mugu
System is used for the solution of engineering problems, particularly those of guided missile design and analysis, and satellite and probe trajectories.

U. S. N. Supersonic Laboratory, M.I.T.
Located at 560 Memorial Drive, Cambridge, Mass., system is used mainly for on line processing of experimental wind tunnel data; e.g. force and moment aerodynamic tests, pressure distribution tests, heat transfer testing, nozzle block calibration, and strain gage balance calibration.

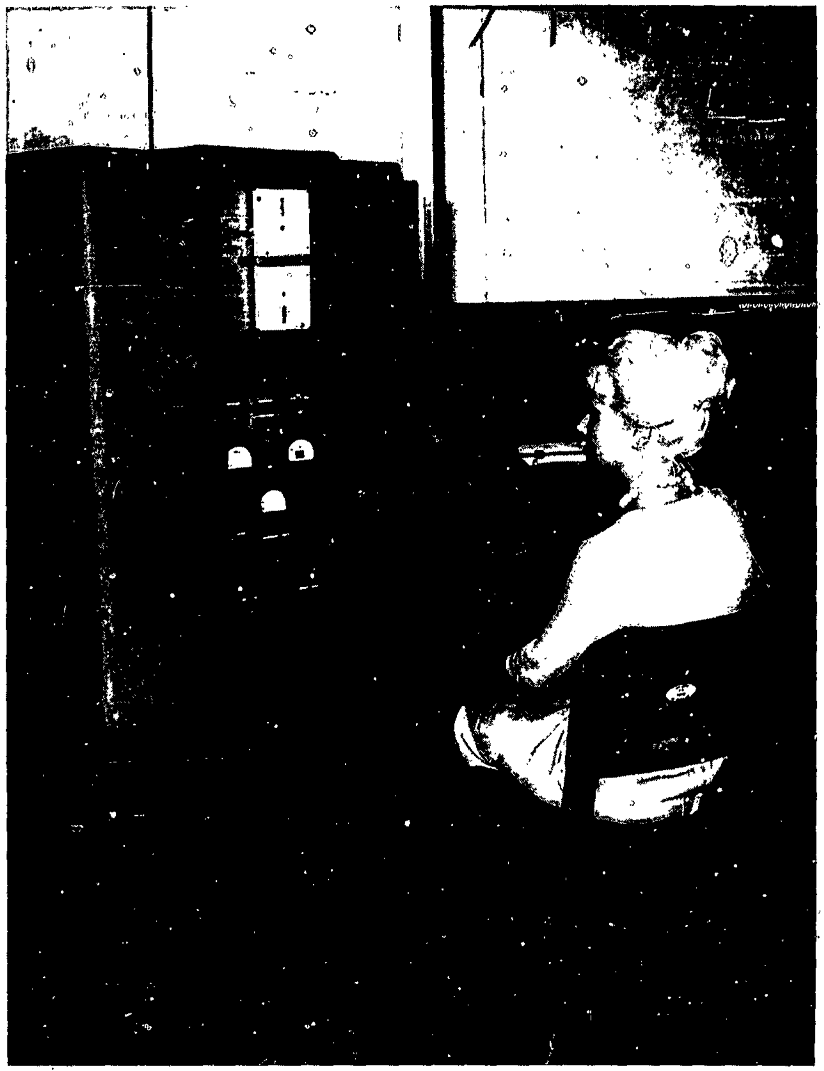


Photo by U.S.A.F. Patrick AFB

U. S. Bureau of Reclamation, Salt Lake City
Located at 32 Exchange Place, Salt Lake City, Utah, the system is used for representative civil engineering computer applications in design, office engineering, project development and construction contract administration work, such as earthwork volumes for roads, canals, borrow pits, multiple linear correlation-forecasting runoff, drain spacing analysis, triangulation and traverse computations, operation studies for reservoirs and related facilities, water surface profiles, and flood routing through a reservoir.

Illinois Division of Highways
Located at the Illinois Division of Highways, Bureau of Research and Planning, State Office Building, Springfield, Illinois, the computer is used for computation of highway cut and fill quantities and pertinent earthwork design data, moment influence line ordinates for 3 and 4-span continuous beams, bridge deck elevations adjusted for dead load deflections, traverse closure and coordinate adjustment, areas, etc., earthwork embankment stability analysis, rectangular and circular column analysis, azimuth determination from sun observation, geodetic position from State plane coordinates and vice versa, and highway letting cost distribution.
This computer is used for the solution of engineering problems only, - problems which require a relatively small amount of input data, but a great amount of complex mathematical computation.

Michigan State Highway Department
Located on the 8th Floor of the S. T. Mason Building, Lansing, Michigan, the system is used by the Michigan State Highway Department, Road Design Division, for earthwork computations, vertical alinement computations, circle-circle, circle-line intersections,

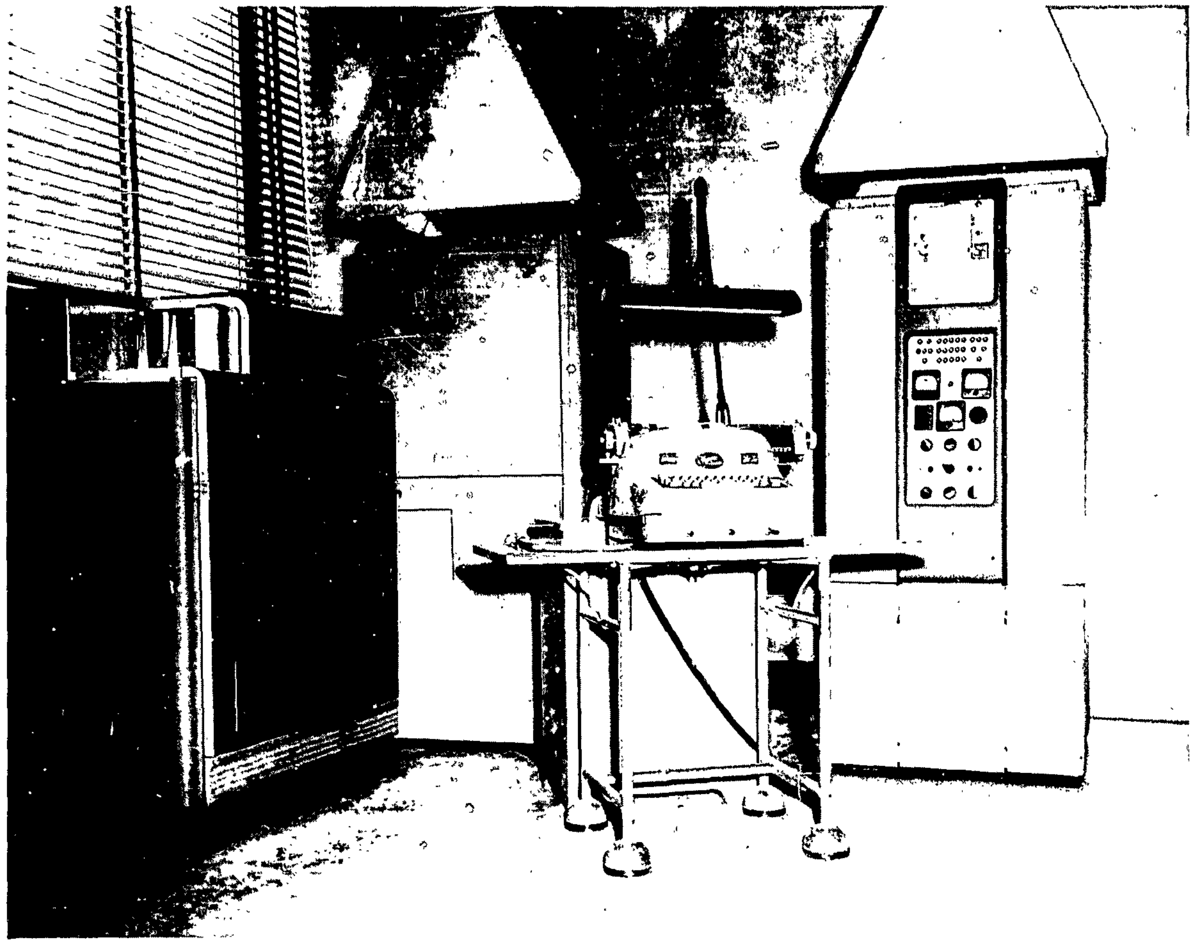


Photo by Michigan State Highway Department

traverse closure computations, and storm sewer design. It is used by the Traffic Division for traffic pattern classification and loadometer. It is used by the Bridge Design Division for circular bridge geometry, vertical alinement, pier design, composite beam design, plate girder design, slab and screed data for the straight bridge, straight bridge elevations, abutment design, and 3, 4, and 5 span girder calculations. The system is also used for bid checking.

AiResearch Mfg. Co. of Arizona
Located at 402 South 36th Street, Phoenix, Arizona, the system is used for test data reduction for gas turbines, starters, pneumatic controls, engineering design problems for various aircraft components, and engineering research problems relative to aircraft and missile components.

Bendix Aviation Corp., Eclipse-Pioneer Division
Located at Plant One, Teterboro, N.J., the system is used for the numerical solution of differential equations, amplitude and polar angles of complex rational functions to facilitate Bode and Nyquist stability analysis, and inverse interpolation programming to find the roots of transcendental equations.

Bendix Radio Division, Bendix Aviation Corp.
Located in the Engineering Bldg., Towson, Md., the system is used for all sorts of scientific, physical problems. The majority have to do with radar systems development.

Bendix Systems Division, The Bendix Corporation
Located at the Data Processing and Display Dept., Bendix Systems Div., Ann Arbor, Michigan, the Bendix G-15A Computer is used in conjunction with CRT Display equipment for the COMPAC Contract. This general purpose computer has been modified for real-time cathode ray tube display of simulated air traffic raids against radar environments.

Dow Chemical Company
Located at the Dow Chemical Company, Engineering Dept., Bldg. B-1201, Room 3129, Freeport, Texas, the system is used for chemical engineering (distillation, heat exchange, flow of fluids, absorption), for mechanical engineering (piping flexibility), for civil engineering (surveying), and for other engineering problems.

Ebasco Services Inc.
Located at 2 Rector Street, New York 6, New York, the system is used for economic calculations, electrical calculations (electric power fields), steam turbo-generator and associated mechanical calculations, pipe stress, and structural analysis.

Fellows Gear Shaper Company
Located in the Engineering Dept., River Street, Spring-

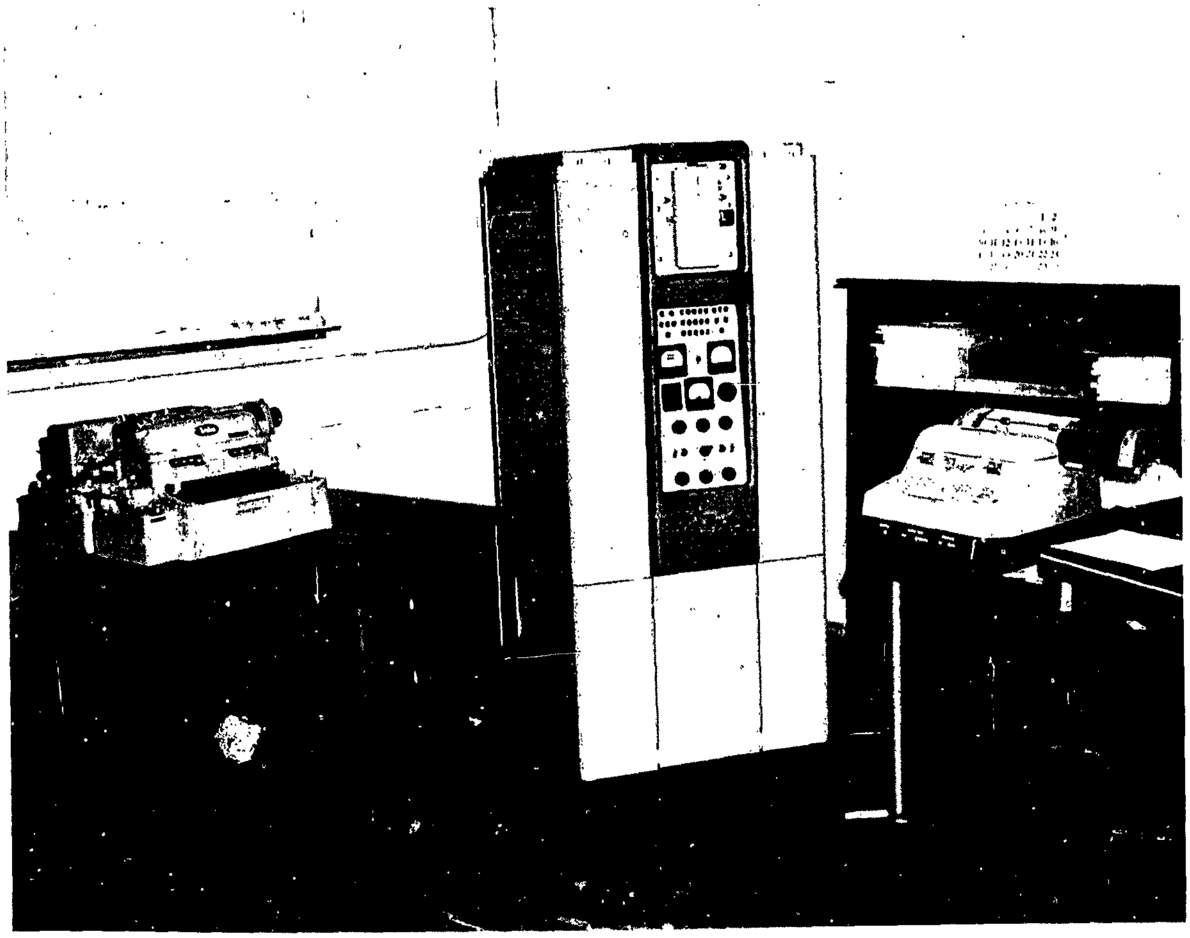


Photo by U. S. Army Engineers, Los Angeles District

field, Vt., the system is used for calculation of all data pertaining to gear shaper helical and spur cutters, master gears, shaving tools, cams, form ground cam cutters, pitch lines of non-circular gears, analysis of gear errors (Fourier coefficient method). The system is used also for the calculation of forces and stresses in molding machines.

Ford Instrument Company
Located in the Engineering Laboratory No. 11, 31-10 Thomson Ave., LIC, N. Y., the whole number machine (G-15D) is used for the solution of equations for nuclear reactor models, cam design, missile and orbital trajectories, on line instrument data processing and data reduction, digital computer design simulation, and solution of matrix (10 x 10) equations for electrical network. The Digital Differential Analyzer is used for nuclear reactor design, inertial platform response, and simulation of navigational systems.

General Mills, Inc., Mechanical Division
Located at 2003 E. Hennepin Ave., Minneapolis 13, Minn., the system is used for data reduction and engineering analysis.

Hercules Powder Co., Applied Mathematics Div.
Located at the Company Home Office, Wilmington 99, Del., the system is used for the solution of engineering problems in distillation calculations, heat transfer calculations, pipe sizing, personnel forecasting, and project accounting. Other applications include multiple correlation, mass spectrometer calculations, rocket trajectory calculations, and specific impulse calculations.

International Harvester Company
Located at 5225 So. Western Blvd., Chicago 9, Illinois, the system is used in engineering design for aerodynamic analysis, thermodynamic analysis, stress analysis, and engine simulation, in data reduction for engine test cell data, in cost reduction for materials handling, and in statistics for regression analysis.

Humble Division, Humble Oil & Refining Company
Located at the Humble Houston Research Center, 3120 Buffalo Speedway, Houston, Texas, the system is used for the study of applicable numerical techniques for predicting the movement of fluids through the pores of reservoir rocks, for the study of applicable techniques for predicting and optimizing drilling operations, for the study of techniques for well log interpretation, and for miscellaneous computation associated with numerous other endeavors in our field of activity.

Lockwood, Kessler & Bartlett, Inc.
Located at One Aerial Way, Syosset, N. Y., the system is used for structural analysis and design, highway

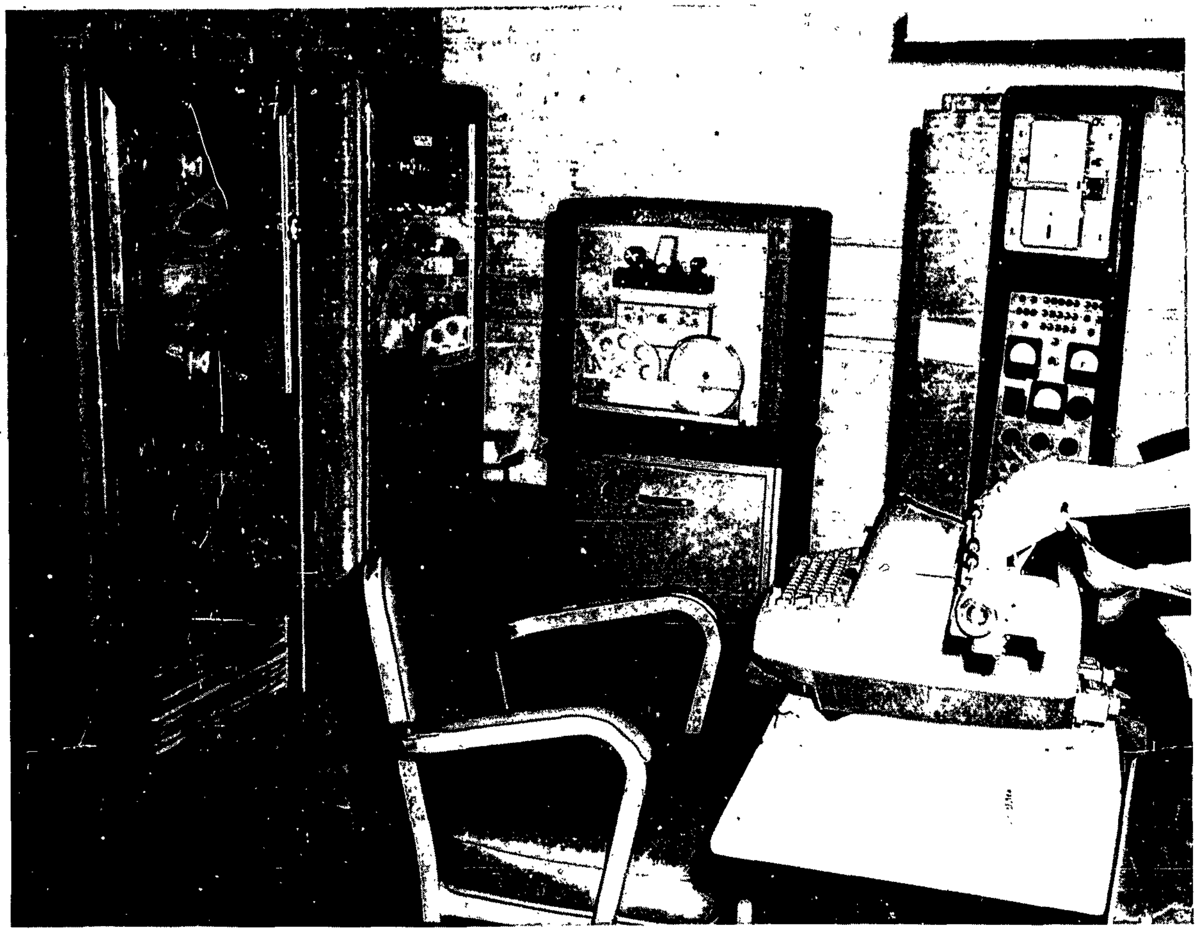


Photo by U. S. Naval Engineering Experimental Station

design and supervision, and surveying and photogrammetry.

The Martin Company
Located at the Manufacturing, Engineering, and Research Dept., Machine Planning Section, Baltimore, Md., the system is used for numerical control, for the manufacture of punched tape to operate numerical control milling machines. It is also used to compute various engineering and mathematical problems.

North American Aviation, Inc., Missile Division
Located at 12214 Lakewood Boulevard, Downey, Calif., the system is used for stability and control, vibrations and flutter, thermodynamics, aerodynamics, preliminary design, trajectory calculations, research and special compilers to prepare tape for airborne computers and ground checkout equipment.

The Ohio Oil Company
Located at Robinson, Illinois, the system is used for mass spectrometer calculations, refinery yield structure, refinery economic studies, linear programming (gasoline blending), gas chromatograph calculations, curve fitting, regression analysis, heat exchanger calculations, and equilibrium flash vaporization calculations.

RCA Service Company, Pan American World Airways
Located at Room 3-059, Bldg. 989, Patrick Air Force Base, Florida, the system is used for mathematical analysis and research in engineering problems and physical sciences such as investigations of mathematical models used in reducing data acquired by various optical and electronic instrumentation, derivation of physical relations in such fields as refraction, geodesy, celestial mechanics, etc., statistical analysis and error propagation studies, and mathematical solutions of a general nature such as solutions of systems of equations, transformations, etc.

Gulf Coast Division, Sun Oil Co., Beaumont
Located at 1096 Calder, Beaumont, Texas, the system is used for reservoir engineering and economic evaluations, reservoir simulation, geophysical calculations, civil and mechanical engineering calculations as applied to petroleum drilling and production technology.

Sun Oil Company Richardson
Located at 503 N. Central Expressway, Richardson, Texas, the system is used for reservoir engineering, differential equations of fluid flow, chemical engineering process calculations, statistical studies, and for data processing of laboratory results.

Vitro Laboratories
Located at 200 Pleasant Valley Way, West Orange, New Jersey, the system is used for analytical studies involving solution of differential equations, matrix

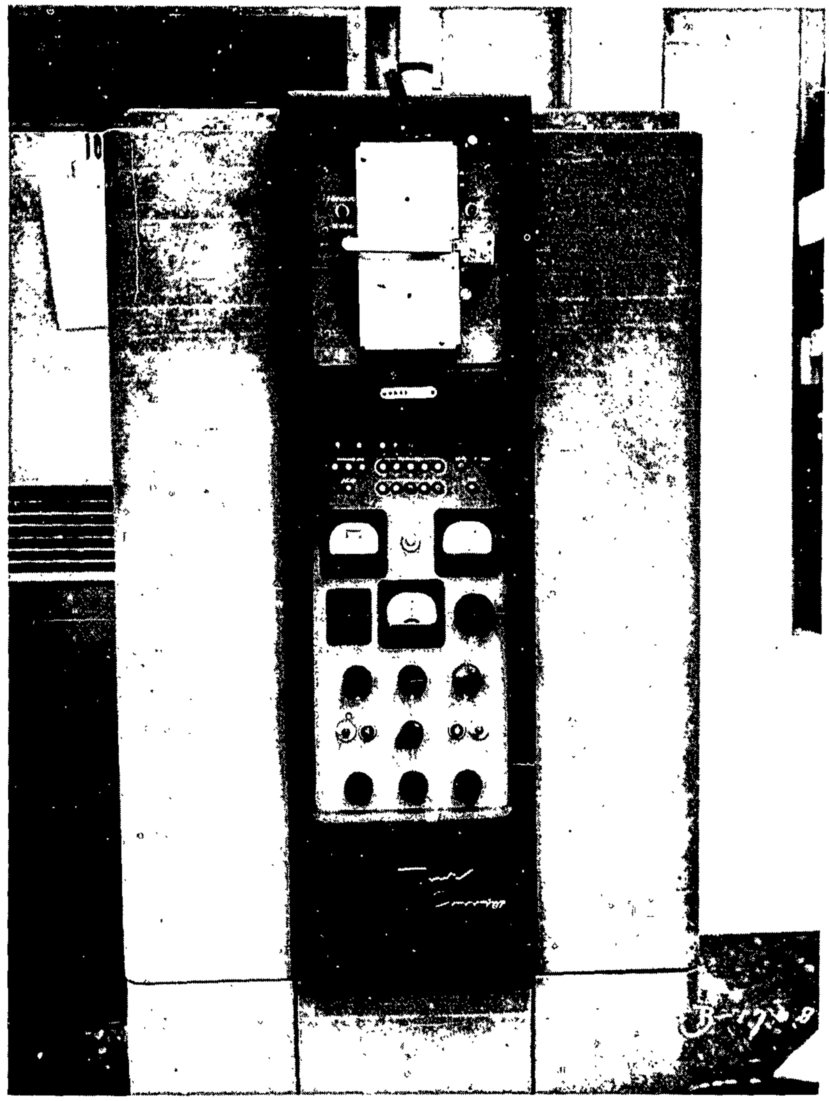


Photo by The Martin Company, Baltimore

algebra, statistical analyses, and general studies.

Pacific Union College Data Processing Laboratory
Located at the Nelson Memorial Library, Pacific Union College, Angwin, California, the system is used as an educational laboratory facility for classes in computer programming and numerical analysis, punched card accounting, research and mathematics, chemical kinetics, nuclear physics, and business management.

Pomona College
Located in the Physics Laboratory, the system is used for the teaching of digital computer techniques and scientific research applications.

Schellenger Research Laboratory, Texas Western College
Located in the Computer Section, the computer is presently being used in contract work for White Sands Missile Range, White Sands, New Mexico. Of particular importance is the SOTIM (Sonic Observations of Trajectories and Impacts of Missiles) program. In addition, applications in acoustics and electronics, particularly problems of sound refraction, calibration, and data reduction, are common.

University of Delaware
Located at the Computing Center, Evans Hall, University of Delaware, the system is used for calculations for research, sponsored and unsponsored (70%), classroom use for coding instruction and demonstration (20%), and for commercial work (10%).

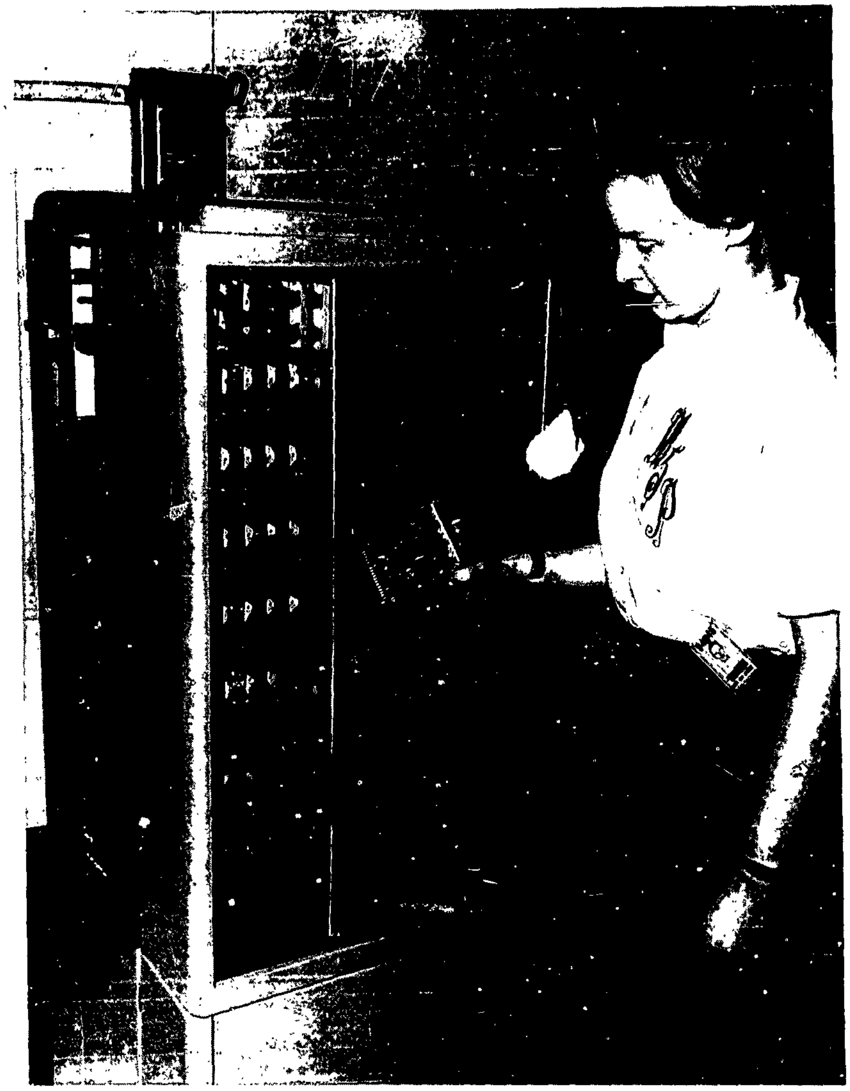


Photo by U. S. Army Map Service

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer	
Internal number system	Binary
Binary digits/word	29
Binary digits/instruction	29
Instructions/word	1
Instructions decoded	125
Arithmetic system	Fixed point (Fractional)
Instruction type	Two address (Modified)
Number range	-2^{57} to $+2^{57}$ (double precision)

Instruction word format

P	Prefix - Normal Command or Deferred
T	Word Time of Operation
BP	Break-Point Halt
N	Location of Next Command
C	Characteristic Operation
S	Source Line
D	Destination Line
S/D	Single or Double Precision

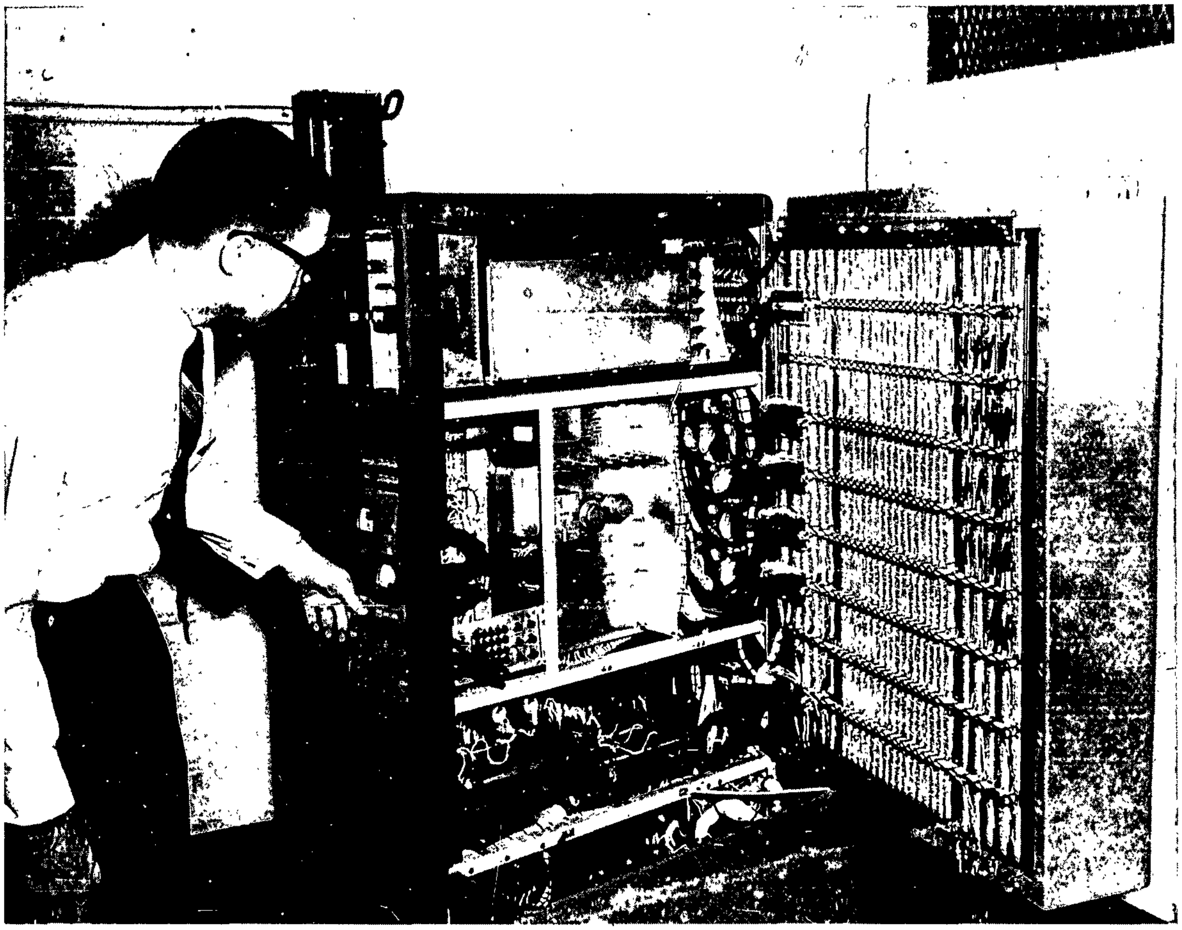


Photo by U. S. Army Map Service

Automatic built-in subroutines include multiply and divide.

Automatic coding includes an algebraic compiler and symbolic assemblers.

Humble Oil

A floating point interpretive system is customarily used. This system permits use of 864 words of storage for commands and operands. It includes indexing and auxiliary storage on a magnetic tape system.

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	540	2.0
Mult	2,430 to 16,700	

Time range for multiply and divide represents range between single decimal digit precision and maximum precision.

Construction (Arithmetic unit only)

Vacuum-tubes	50 Approx.

Short tracks used on drum.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Medium	No. of Words	No. of Bin/Dig	Access Microsec
Magnetic Drum	2,176	63,104	14,500 avg 540 min

Magnetic Tape

No. of units that can be connected	4 Units
No. of char/linear inch of tape	57 Char/inch
Channels or tracks on the tape	6 Tracks/tape
Blank tape separating each record	0.5 Inches
Tape speed	7.5 Inches/sec
Transfer rate	427 Char/sec
Start time	15 Millisec
Stop time	15 Millisec
Average time for experienced operator to change reel of tape	150 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	3,600 Feet
Composition	Mylar

All installations require the use of magnetic drum storage.

Photo by U. S. Army Map Service

The following installations utilize magnetic tape storage:

USA AMS	Hercules Powder
USA C and G SC	Humble Oil
USA Ord WSMR	The Martin Company, Baltimore
USN Bu Weap	North American
USN EES	Ohio Oil
USN MC Pt Mugu	SUNOCO Richardson
USN SL MIT	Vitro Labs
AiResearch	Pacific Union College
Fellows	Pomona College
General Mills	Univ of Del

INPUT

Manufacturer Media	Speed	
Typewriter	8 char/sec	(Full alphanumeric)
Card Reader	100 cards/min	(Full alphanumeric)
Paper Tape (Optional)	400 char/sec	(Sexadecimal)
Paper Tape (Standard)	250 char/sec	(Sexadecimal)

All installations utilize paper tape input and output.

All installations utilize the typewriter (Flexowriter) input and output.

The following installations utilize punched cards for input-output.

Michigan SHD	North American
General Mills	Pacific Union College
Hercules Powder	

OUTPUT

Manufacturer Media	Speed	
Typewriter	11 char/sec	(Numeric)
	8.5 char/sec	(Alphanumeric)
Cards	100 cards/min	
Line Printer (IBM 402)	100 lines/min	(80 char/line)
Paper Tape (Standard)	17 char/sec	(Sexadecimal)
Paper Tape (Optional)	60 char/sec	(Sexadecimal)

The graph plotter can be driven by the computer at 200 increments/second and 100 increments/inch or by the digital differential analyzer at 34 increments/second.

The following organizations utilize the line printer:

AiResearch	Pacific Union College
North American	

The following organizations utilize the graph plotter:

USN SL MIT	Bendix Radio

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type		
Tubes		
Computer	Approx.	450 (Mostly dual triodes)
DDA	Approx.	75
Card Coupler	Approx.	310
Diodes		
Computer	Approx.	2,500
DDA	Approx.	800
Card Coupler	Approx.	1,100
Transistors		16 (In typewriter coupler)

All logic is mounted on plug-in packages.

CHECKING FEATURES

Several test commands are available.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	3.5 Kw	0.98 pf
Volume, computer	31 cu ft	
Area, computer	6 sq ft	
Room size, computer	8 ft x 8 ft	
Floor loading	160 lbs/sq ft	
	250 lbs concen max	
Weight, computer	1,000 lbs	

110 V, 50a, 60 cycle line.

No special air conditioning is required if adequate ventilation is provided and approved by contractor.

USA C and G SC

Power: Install 110 volt, single phase, three-wire system.

Air conditioning: If room is small or poorly ventilated, install hood or air conditioner. If room is large enough, no air conditioning required. Heat from computer is 14,300 BTU/hr, and from magnetic tape unit is 2,200 BTU/hr.

USA Eng LRD

Permanent installation will be in a Federal building now under construction. Temporary quarters will provide 8 ft high partitions open above to 14 ft 6 in. ceiling of masonry building. Window-unit type A/C (220 V.) to be installed in outside wall.

USA Eng LAD

Installation of 110-volt, single-phase, three wire system (third wire for equipment ground). Installation of air conditioners through window opening and 220-volt circuit.

USA MS

No unusual site preparation.

USN Bu Weap

Installation of adequate power lines, and acoustics material on walls.

USN CS

Provided metal partition enclosure in drafting room; also provided single 115 volt 50 ampere line.

USN EES

Special air-conditioning air ducts were installed to bring in cooled air from another part of the building.

USN MC Pt Mugu

Installation of 50 amp line. Installation of recirculating fans.

USN SL MIT

Computer installed in large air conditioned area.

US B of R

Installed 50 amp., 110 volt line from source. Installed hood, 18 inch duct and squirrel cage vent fan with 3/4 hp. motor. Cut window in outside wall for installation of air conditioners. Added drywall partition and door.

Michigan SHD

Sufficient ventilation should be provided to keep ambient room temperature below 80 degrees F. A 50 ampere line is recommended, which includes 2.0 amps for HSPR-5 or 7 and 2.9 amps for 35-4. All equipment requiring external power operates from a 110 volt, single-phase, three wire system, the third wire is an equipment ground. A 220 volt, three-wire, single-phase system will not be acceptable.

AiResearch

Power, computer	10 Kw	10 KVA	1.0 pf
Volume, computer		30.5 cu ft	
Area, computer		6.0 sq ft	
Room size, computer		32 x 25 x 10 (No specific requirement)	
Floor loading		160 lbs/sq ft	
		240 lbs concen max	
Weight, computer		965 lbs	

No special preparation except power requirements and voltage regulators.

Bendix Radio

Addition to existing air conditioning system only.

Bendix Systems

System is presently operated in an air conditioned environment, but has been operated successfully without air conditioning. No special site preparation required.

Ebasco

Installed power supply for computer.

Fellows

Room divided from general engineering room by removable panels, about 1/2 glass, 1/2 wood, approx. 7 ft high. No other preparation necessary. (Uses 110 volt line).

Ford Instrument

Requires 50 amp. wiring for single phase, 115v, 60 cycle power.

General Mills

Constant voltage transformer required.

Hercules Powder

No special precautions required in normal office building except raised floor for weight distribution. Have separate 200A. 3 wire 220V. power supply. One computer (110V) on each side. Excess heat removed by exhaust hoods.

International Harvester

Transformer installed to convert 440 AC to 110 AC in order to be able to carry a 40 amp fuse on a 110V line.

Humble Oil

One 115 volt 50 amp. overload protected circuit.

L, K, and B

Installed one ceiling exhaust fan. Installed wire mesh (2 in. high) in place of floor board.

The Martin Company Baltimore

2 in. x 4 in. wood frame, glass and sheet celotex walls, celotex ceiling of 12 in. x 12 in. perforated blocks, cement and tile floor (basement). Temperature and humidity controlled room. Power Distribution - 110V for computer and lighting, 440 (3) phase for air conditioner.

North American

Site is air conditioned but need not be for the operation of the equipment provided room temperature is approximately 75°F.

Ohio Oil

50 amp, 110V circuit.

RCA - PAWA

50 amp., 110V supply. 50° < room temperature < 80° (Ideal temp., 77°).

SUNOCO Beaumont
Installation of 110 volt, 50 amp., single phase, three wire system.
SUNOCO Richardson
Installation of ventahood.
Vitro Labs
Installation in accordance with manufacturer's recommendations.
Pacific Union College
No special modifications were necessary for the installation of this equipment with the exception of a ventilating air duct to remove air warmed by the computer.
Pomona College
115 volts, 50 amp outlet. Local air conditioner installed in false ceiling.
Texas Western
50 amp, 110 volt, 3 wire line.

PRODUCTION RECORD

Manufacturer

Number produced to date	Over 300
Number in current operation	Over 300
Time required for delivery	1 to 2 months

COST, PRICE AND RENTAL RATES

USA AMS
Basic System
$1,485 per month.
Additional Equipment
Magnetic Tape Unit - $270 per month.
USA C and G SC

Basic System	Purchase	Monthly Lease
G-15 Computer w/alphanumeric typewriter	$51,000	$1,530
MTA-2 Magnetic Tape Unit	6,800	270
	$57,800	$1,800
Additional Equipment		
Punch Card Coupler CA-2	$19,500	$582
Graph Plotter PA-3	2,500	130

Maintenance is part of lease price. This includes parts and labor. If computer is purchased, a maintenance contract may be entered into at the following rates:

G-15 Computer	$500/month
MTA-2 Tape Unit	50/month

USA Eng LRD

Additional Equipment	Cost
20-inch carriage w/pin-feet platen	$ 400
Clary Model 148.067/703 Add-Punch	1,900

Basic System
$1,530 per month rental rate.
USA Eng LAD

Basic System	Cost	Monthly Rental
Main frame including typewriter	$49,500	$1,485
Additional Equipment		
Flexowriter	2,900	

Computer maintenance included in rental price.
Flexowriter - 1 yr. warranty. Service contract $150 per year thereafter.
USA MS
Bendix G15D Basic Computer $49,500 full purchase price.
Flexowriter: $3,144 full purchase price.
Weekly scheduled maintenance and immediate repairs by Bendix Computer: $6,000/annum.

USA Frankford Arsenal
Computer and typewriter - $1,485 per month.
USA Ord WSMR
G-15D General Purpose Computer $1,530 per month.
MTA-2 Magnetic Tape, DA-1 Digital Differential Analyzer, Graph Plotters - Total: $895 per month.
USA Snow Ice Perma
Bendix G-15D and typewriter $1,485/month.
USN ADC
Cost of basic system: Approximately $50,000.
USN Bu Weap
Bendix Maintenance Contract $6,000 per year.
USN CS
Rental for G-15D Basic Unit: $1,485 per month.
USN EES
Rental rates for prime shift: G15D Bendix, $1,530 per month; MTA 2 magnetic tape units, $540 per month; PR-2, $130 per month.
USN HO Suitland
Main frame and typewriter rents for $1,485 per month.
USN MDL
$48,000 for computer only.
USN MC Pt Mugu
Basic computer cost $49,500.
Digital Differential Analyzer (DA-1) cost $13,700.
Magnetic Tape cost $6,800.
USN SL MIT
G-15A, special input unit, 2 MTA-2, 2 off line Flexowriters cost $82,000.
Plotters and shift register cost $25,000.
Do own maintenance.
US B of R
Flexowriter cost $3,060.
Computer, Bendix G15D rents for $1,485 per month.
Flexowriter rents for $150 per month.
Flexowriter maintenance is $150 per year.
Illinois D of H
Additional Equipment
Flexowriter cost $2,800.
Basic System
$1,485 per month.
Michigan SHD
Additional Equipment
2 Flexowriters at $2,900 each.
Basic System
Bendix G-15D Computer and electric typewriter $1,485 per month.
Additional Equipment

IBM 523	$85/month
Bendix CA-2 Card Converter	450/month
IBM 024	38/month
IBM 056	48/month

AiResearch
G-15 Computer, $1,524/month; Total Systems $4,590 per month.
Rental Rates for Additional Equipment

4 Magnetic Tape Units at $270	$1,280
1 Bendix CA-2, Card Converter	850
1 IBM 402 Printer	400
2 IBM 523 Summary Punch at $100	200
1 IBM 082 Sorter	65
1 IBM 519 Reproducer	150
2 IBM 026 Key Punch at $60	120
Total Rent for Month for Additional Equipment	$3,065

Bendix Eclipse-Pioneer
Cost for Basic System
$50,000 per G-15A general purpose digital computer
Cost for Additional Equipment
$10,000 per Digital Differential Analyzer.

Bendix Systems

Computer purchased by U. S. Air Force for $32,980 (used price).

A technician has been trained to perform the preventative maintenance necessary on this piece of equipment.

Dow Chemical

Computer and typewriter $1,485/month.

Ebasco

$1,485/month + tax, including maintenance.

Fellows

	Cost
Basic Computer	$49,500
Magnetic Tape Unit	6,800
DA-1	5,000

DA-1 has gone up to $13,700 now.

We do our own maintenance and servicing.

Ford Instrument

Rental for Basic System

Computer and printer $1,500 per month

Rental for Additional Equipment

Differential Analyzer 625 per month

General Mills

Basic System	Cost	Rental
Computer and typewriter	$50,000	$1,485/mo.
Additional Equipment		
4 Magnetic Tape Units	$6,800	$270/mo.
1 DA-1 Differential Analyzer	13,700	550/mo.
1 Card Coupler w/IBM 523 Summary Punch	19,500 +	674/mo.
1 DA-2 Digital Plotter	2,500	100/mo.

Bendix Maintenance Contract ; $700/month for purchased installation.

Hercules Powder

G-15D rents for $1,485 per month (each unit).

CA-2 Rents for $450/month and MTA-2 for $270/month (each unit).

International Harvester

G-15A General Purpose Computer rents for $1,485/month.

Humble Oil

G-15A costs $45,000.

2 Potter Magnetic Tape Transports cost $10,000.

Maintenance is performed by Humble.

L, K, and B

Computer cost $49,500.

Computer rents for $1,485/month (including maintenance and service).

North American

Total installation equivalent cost $191,500.

Total installation equivalent rental $6,100/month.

Basic G-15D cost - $49,500.

Basic G-15D rental - $1,500/month.

Maintenance by Bendix $500/month.

Ohio Oil

Rental for Basic System

Computer plus typewriter for control + input - output $1,485/month.

Rental for Additional Equipment

Magnetic Tape Unit, $270/month x 2 = $540/month.

RCA - PAWA

Rental for Basic System

$1,530/month (176 hours).

SUNOCO Beaumont

Bendix G-15 cost $60,000.

Bendix G-15 rents for $1,530 per month.

Maintenance by Bendix service engineer included in lease contract.

SUNOCO Richardson

Cost for Basic System

Bendix G-15D Computer and IBM typewriter $49,500.

Cost for Additional Equipment

2 Magnetic Tape Units $6,800 each

1 Flexowriter 3,000

Bendix G-15D Computer and IBM typewriter rents for $1,485 per month.

2 MTA $540/month

1 Flexowriter 165/month

Maintenance service contract: $600/month (included in lease proce).

Pacific Union College

	Cost
G-15	$50,000
Two magnetic tape units	22,000
CA-2 Card Converter	15,000
	Rental
IBM 402 514026182	$ 325/month

We do our own maintenance.

Pomona College

G-15D cost $32,000.

MTA-2 cost $ 7,000.

Texas Western

Typewriter, paper-tape punch, photo-electric reader $1,300.50/month, including maintenance/service.

Univ of Del

G-15D cost $29,700 (after 40% educational contribution).

MTA-2 magnetic tape unit cost $6,800.

Maintenance service $360.month (after 40% educational contribution).

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	1	1
Analysts			2
Programmers	2	4	6
Operators	1	1	2

Training made available by the manufacturer to the user includes programming and operation training at no cost to the user.

The G-15 Computer is generally used as an open shop computer, thus many engineers and mathematicians utilize the equipment as a tool for solving their problems.

USA C and G SC

1 Programmer, 1 Operator; formal classes of instruction are given by Bendix personnel at our request. Individual training or assistance is given by our computer room personnel as required.

USA AMS

1 Supervisor-analyst, 2.5 programmers, 6 coders; open shop; courses by Department and manufacturer.

USA Eng LRD

A number of engineers from technical sections of the District will be trained in the use of Intercom 1000; open shop.

USA Eng LAD

1 Supervisor, 1 analyst, 2 programmers, 1 clerk, 1 operator; manufacturer's courses and on-the-job continuation training.

USA MS

1 Supervisor, 1 programmer (2 recommended), 1 operator; open shop; supervisor is also analyst, programmer, and coder, programmer is also analyst and coder; computer personnel selected on basis of geodetic and mathematical experience, attend three week course in programming and operation given by Bendix Computer.

USA Frankford Arsenal

Operators are any one of 4 engineers, 1 technician; closed shop; operations tend toward closed shop because of work load involved, little formal training is needed for operation of machine.

USA Ord WSMR

75 Engineers; open shop; factory representatives gave a four week class in machine language programming of GS-15D and DA-1 Digital Differential Analyzer, one week course given to selected engineers in an interpretative programming method (Intercomm 1000).

USA Snow Ice Perma

1 Analyst, 1 programmer, 1 operator; Bendix School for machine language, train own employees for "Intercomm" Interpretive system.

USN ADC

Personnel shared with IBM 650 RAMAC; closed shop; standard Bendix courses, on-the-job training.

USN Bu Weap

1 Programmer; open shop; Bendix prepared instruction courses.

USN CS

We have no full time computer group. We operate an open shop. All engineers and technicians have access to the machine. This is a scientific type computer and is used solely to solve scientific problems. The Design Division Administrative Branch, is responsible for the administrative scheduling of time, records, reports, and maintenance of the computer. The technical codes have certain experts that take the lead in training and programming. Initially 3 engineers were trained by Bendix Computer Firm. The trained operators in turn indoctrinate and train others.

USN EES

1 Supervisor, 1 programmer, 1 operator; open shop; Intercom - 1000 classes on station were attended by 74 employees, eight employees attended three-week course in machine language at Bendix office in Washington, D. C.

USN HO Suitland

1 Supervisor, 7 scientific personnel use facility as required; on-the-job training.

USN MDL

Personnel as required for project work load. Programmers trained by Bendix Corp.

USN MC Pt Mugu

1 Supervisor, 4 programmers; open shop; school (by manufacturer), simplified coding (by manufacturer and this organization).

USN SL MIT

Two 8-hour shift: 1 supervisor, 2 programmers, 3 engineers, 1 input-output operator; closed shop; programmers and operators attend Bendix Computer Division courses in programming and/or computer logic, when used for on line work, the operators must be able to repair the computer in the event of breakdown. This is made necessary by the cost of wind tunnel time.

US B of R

1 Supervisor, 2 programmers, 1 operator, 1 tape handler are used. Same recommended, plus 0.5 clerk and 1 more tape handler, for data tape preparation on 2 Flexowriters; manufacturer's programming courses and on-the-job training are used.

Illinois D of H

1 Supervisor, 2 programmers, 1 operator, 1 in-output operator are used, recommended same. Programmers attend a 3-week, 8-hr. day programming school. Others receive on-the-job training.

Michigan SHD

1 Supervisor, 2 programmers, 1 operator, 1 engineer, 1 in-output operator are used, recommended same plus 2 more programmers; closed shop; training: Bendix Computer 3 week machine language programming school, Bendix Computer 1 week card converter programming school, on-the-job training in machine language programming and interpretive programming routines, IBM 1 week key punch operator school, and on-the-job training in computer operation and accessory equipment.

AiResearch

1 Supervisor, 5 programmers, recommended same; closed shop; Bendix Computer Division sponsored training program. On-the-job training by Bendix representatives and supervisor.

Bendix Eclipse-Pioneer

1 Supervisor, 1 analyst, 2 programmers, 2 technicians; closed shop; bachelor's degree with a major in mathematics is the minimum requirement for a programmer. Master's degree absolute minimum requirement for analyst; on-the-job training through programming simple practical problems.

Bendix Radio

1 Supervisor, 2 programmers; closed shop; on-the-job training.

Bendix Systems

One 8-Hour Shift: 1 programmer, 1 coder, 1 operator, recommended same; closed shop; this facility is operated closed shop because it is being used exclusively on one contract; programmers are sent to a class at Bendix Computer Division's Customer Training Center.

Dow Chemical

One engineer is responsible for the computer operation and spends approximately 60% of his time in computer operation and programming. Other individual engineers use computer as occasions arise. No non-salary personnel involved.

Ebasco

Training includes manufacturer programming courses and our own classes.

Fellows

1 Supervisor, 1 programmer, 1 clerk; recommended same; closed shop; supervisor and programmer took 3 weeks course at Bendix plant.

Ford Instrument

Open shop; courses given by Bendix (manufacturer and lessor), in-plant training by personnel familiar with operation of computer.

General Mills

0.5 Supervisor, 2 analysts, 4 programmers; recommended full time supervisor plus 2 more programmers; open shop; self-taught interpretive programming, periodic classes in machine language (installation sponsored).

Hercules Powder

0.5 Supervisor, 1.5 analysts, 4 programmer-coders, 0.5 clerk, 0.5 operator are used; recommended 1 supervisor, 2 analysts, 5 programmer-coders, 1 clerk, 1 operator; open shop; training is informal and internal.

International Harvester

1 Supervisor, 1 analyst, 1 programmer, 5 engineers, 2 technicians are used; 5 more engineers and 6 more technicians are recommended; open shop; in operating on an open shop basis we have only one non-supervisory person assigned to the computer. He does not spend full time at the machine. Operation is on a first come first served basis except that no service is given our technical personnel as far as machine usage is concerned. We do assist, on request, with numerical analysis and the development of service routines. The personnel noted above are indicative of the number and kinds of people utilizing the computer; a 4 hour training course in an interpretive system is given to all technical employees. No basic language is taught at all except to one programmer.

Humble Oil

Three 8-Hour Shift: 1 supervisor, 2 analysts, 3 programmers, 0.5 operator, 0.5 technician; open shop; a Bendix G-15 D drum computer system is maintained and operated by the Petroleum Engineering Section of the Production Department of the Humble Division. This installation is similar to the one described here.

The purpose of the work done is in part to put into practice developments made here in the Production Research Division; assistance to potentially interested users by personnel responsible for the system.

L, K, and B

1 Supervisor, 1 programmer, 1 clerk, recommended same; closed shop; attending a programming course.

The Martin Company Baltimore

1 Supervisor, 2 programmers, 1 operator, recommended same; open shop; manuals.

North American

1 Supervisor, 4 programmers, 1 operator, 6 engineers, 1 in-output operator; engineers from all groups are given classes in programming. They may write their own programs and operate the machine if desired. A staff of 10 engineers and mathematicians are available for those groups of engineers who request assistance.

Ohio Oil

2 Programmers, 1 operator; on-the-job training and training classes conducted by the lessor.

RCA - PAWA

1 Supervisor, 1 clerk recommended; open shop; personnel desiring programming instructions are trained by Bendix Computer instructiors in the use of the Intercom 1000 system.

SUNOCO Beaumont

1 Supervisor, 6 engineers, 1 technician; closed shop; all members of the Reservoir Analytical Section can operate and write programs for the computer; programming classes and applications.

SUNOCO Richardson

1 Supervisor, 7 programmers, 1 operator; open shop.

Vitro Labs

1 Supervisor, 2 programmers, 1 in-output operator; closed shop; attendance at Bendix training course.

Pacific Union College

1 Supervisor, 2 programmers, 2 coders, 1 technician; open shop; informal apprenticeships and formal class instruction.

Pomona College

Open shop; classes conducted etc. Interpretative systems used extensively.

Texas Western

1 Supervisor, 2 programmers, 2 operators, 1 tape handler; open shop; informal short classes in programming and computer operation.

Univ of Del

0.5 Supervisor, 0.5 clerk; 1 supervisor and 1 clerk recommended; open shop; open shop training from manuals with minimal formal instruction in large classes.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USA AMS

Average error-free running period 100 Hours
Good time 38.8 Hours/Week (Average)
Attempted to run time 40.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.970
Above figures based on period from May 58 to Jun 60
Passed Customer Acceptance Test May 58
Time is not available for rent to outside organizations.

USA C and G SC

Average error-free running period 2 - 3 Weeks
Good time 35 Hours/Week (Average)
Attempted to run time 36 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period 1 Apr 60 to 19 Aug 60
Passed Customer Acceptance Test 31 Mar 60
Time is available for rent to qualified outside organizations.

Computer is available for other agencies if time available on an 8-hour day basis.

USA Eng LAD

Good time 43.8 Hours/Week (Average)
Above figure based on period 1 Jan 59 to 31 Dec 59
Passed Customer Acceptance Test 1 Mar 58
Time is not available for rent to outside organizations.

43.8 hours per week shown above as "good time" is the average hours per week the computer was functioning properly excluding time during regular and emergency maintenance. Emergency maintenance amounted to approximately 3 percent of total time. Most of emergency maintenance was due to malfunction of the computer typewriter.

USA MS

Average error-free running period 1 Month
Good time 41.1 Hours/Week (Average)
Attempted to run time 42.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period 1 Jan 59 to 1 Jan 60
Passed Customer Acceptance Test Nov 57
Time is not available for rent to outside organizations.

USA Frankford Arsenal

Good time 37.7 Hours/Week (Average)
Attempted to run time 37.9 Hours/Week (Average)
Operating ratio 0.9947
Above figures based on period 3 Jan 59 to 9 Apr 60
Passed Customer Acceptance Test 30 Dec 58
Time is available for rent to qualified outside organizations.

Time is made available to outside organizations for certain problems.

USA Ord WSMR

Good time 29 Hours/Week (Average)
Attempted to run time 30 Hours/Week (Average)
Operating ratio 0.97
Above figures based on period 1 Feb 60 to 13 May 60
Passed Customer Acceptance Test 21 Jan 60
Time is not available for rent to outside organizations.

Machine is in restricted area from a security standpoint.

USA Snow Ice Perma

Good time 36 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.90
Above figures based on period from Oct 58 to present
Passed Customer Acceptance Test Oct 58
Time is not available for rent to outside organizations.

USN Bu Weap

Good time 42 Hours/Week (Average)
Attempted to run time 42 Hours/Week (Average)
Operating ratio 0.99
Above figures based on period 1 Jul 59 to 1 Jul 60
Passed Customer Acceptance Test 16 Aug 57
Time is not available for rent to outside organizations.

USN CS

Operating ratio 0.95
Above figures based on period 22 May 59 to present
Passed Customer Acceptance Test 22 May 59
Time is not available for rent to outside organizations.

Average number of hours per week that we attempt to use this computer varies from 25 to 48 hours. It has been our experience that the machine is operable 95% of the time and down 5% of the time.

USN EES

Operating ratio 0.96
Above figure based on period 12 Nov 59 to 31 Jul 60
Time is not available for rent to outside organizations.

System is operated full time.

We now schedule computer for three 8-hr. shifts:
Prime Shift - Debugging and "one-shot" type problems.
Second Shift - Operator types in data
Third Shift - Unattended computation and type-out.

USN HO Suitland

Good time 40 to 60 Hours/Week (Average)
Attempted to run time 40 to 60 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period from Jan 58 to Apr 60
Time is not available for rent to outside organizations.

USN MDL

This computer was purchased for a special application and its maintenance requirements varies from the normal because of the extreme environment conditions to which it has been exposed.

USN MC Pt Mugu

Average error-free running period 40 Hours
Good time 48 Hours/Week (Average)
Attempted to run time 50 Hours/Week (Average)
Operating ratio 0.96
Above figures based on period 1 Apr 60 to 30 Apr 60
Passed Customer Acceptance Test 29 Jun 59
Time is not available for rent to outside organizations.
Time available to outside organizations if they have programming personnel. The simplified coding system in general use allows wide-spread knowledge of programming. No rental is involved in this time.

USN SL MIT

Average error-free running period Two Days
Operating ratio 0.90
Above figures based on period from Mar 56 to present
Passed Customer Acceptance Test Mar 56
Time is available for rent to qualified outside organizations.

US B of R

Good time 36 Hours/Week (Average)
Attempted to run time 39 Hours/Week (Average)
Operating ratio 0.91
Above figures based on period 1 Jul 59 to 1 Jul 60
Passed Customer Acceptance Test 5 Nov 58
Time is not available for rent to outside organizations.

Illinois D of H

Good time 36 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.90
Above figures based on period 1 Jan 59 to 1 Jan 60
Passed Customer Acceptance Test Sep 56
Time is not available for rent to outside organizations.

Michigan SHD

Good time 50.25 Hours/Week (Average)
Attempted to run time 55.83 Hours/Week (Average)
Operating ratio 0.90
Above figures based on period 3 Jan 60 to 3 Apr 60
Passed Customer Acceptance Test Sep 56
Time is not available for rent to outside organizations.

AiResearch

Good time 34 Hours/Week (Average)
Attempted to run time 36 Hours/Week (Average)
Operating ratio 0.944
Above figures based on period 1 Oct 59 to 1 May 60
Passed Customer Acceptance Test Basic System 15 Sep 60
Time is not available for rent to outside organizations.

Bendix Eclipse-Pioneer

Good time 32 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.80
Abive figures based on period 1 Jan 60 to 1 May 60
Time is not available for rent to outside organizations.

Bendix Radio

Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period from May 59 to Apr 60
Time is available for rent to qualified outside organizations.

Bendix Systems

Average error-free running period 20 Hours
Good time 35 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.88
Above figures based on period from Oct 58 to May 60
Passed Customer Acceptance Test 30 Oct 58
Time is not available for rent to outside organizations.

Dow Chemical

Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period from Nov 57 to Sep 60
Passed Customer Acceptance Test Apr 58
Time is not available for rent to outside organizations.

Fellows

Good time 43.5 Hours/Week (Average)
Attempted to run time 43.5 Hours/Week (Average)
Operating ratio 0.997
Above figures based on period 15 Jan 60 to 15 Apr 60
Passed Customer Acceptance Test Jul 57
Time is not available for rent to outside organizations.
We schedule 1 1/2 hours per week for preventive maintenance. In the last 3 months, we have had 1 1/2 hours of unscheduled "down" time.

Ford Instrument

Average error-free running period 8 Hours
Good time 34 Hours/Week (Average)
Attempted to run time 36 Hours/Week (Average)
Operating ratio 0.94
Above figures based on period 1 Jan 60 to 26 Aug 60
Time is not available for rent to outside organizations.
4 hour preventive maintenance operation scheduled each week.

General Mills

Good time 60 Hours/Week (Average)
Attempted to run time 60 Hours/Week (Average)
Operating ratio 1.0
Above figures based on period from Aug 58 to present
Passed Customer Acceptance Test 1 Jan 57
Time is available for rent to qualified outside organizations.

Hercules Powder

Average error-free running period About 3 Days
Good time 52.4 Hours/Week (Average)
Attempted to run time 54.5 Hours/Week (Average)
Operating ratio 0.96
Above figures based on period 1 Dec 59 to 29 Feb 60
Passed Customer Acceptance Test Jan 59
Time is not available for rent to outside organizations.

International Harvester

Good time 34.3 Hours/Week (Average)
Attempted to run time 36 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period 1 Mar 60 to 4 Jun 60
Passed Customer Acceptance Test 1 Mar 60
Time is not available for rent to outside organizations.

Humble Oil
Average error-free running period 18 Hours
Good time 140 Hours/Week (Average)
Attempted to run time 163 Hours/Week (Average)
Operating ratio 0.86
Above figures based on period from Aug 56 to Jan 60
Passed Customer Acceptance Test Sep 55
Time is not available for rent to outside organizations.
This system has been found sufficiently reliable to operate unattended nightly and for complete weekend periods.

L, K, and B
Good time 39 Hours/Week (Average)
Above figure based on period from Nov 57 to Apr 60
Passed Customer Acceptance Test Nov 57
Time is not available for rent to outside organizations.

The Martin Company Baltimore
Average error-free running period 40 Hours
Good time 30 Hours/Week (Average)
Attempted to run time 36 Hours/Week (Average)
Operating ratio 0.833
Above figures based on period 1 Jan 59 to 1 Jan 60
Passed Customer Acceptance Test 5 Sep 56
Time is available for rent to outside organizations.

North American
Good time 79 Hours/Week (Average)
Attempted to run time 80 Hours/Week (Average)
Operating ratio 0.988
Above figures based on period 1 Jun 59 to 1 May 60
Passed Customer Acceptance Test Aug 58
Time is available for rent to outside organizations.

Ohio Oil
Good time 61.19 Hours/Week (Average)
Attempted to run time 64.25 Hours/Week (Average)
Operating ratio 0.9524
Above figures based on period 1 Jan 59 to 1 Jan 60
Passed Customer Acceptance Test May 58
Time is not available for rent to outside organizations.

SUNOCO Beaumont
Good time 79 Hours/Week (Average)
Attempted to run time 84 Hours/Week (Average)
Operating ratio 0.9405
Above figures based on period 16 Feb 60 to 29 Aug 60
Passed Customer Acceptance Test 16 Feb 60
Time is not available for rent to outside organizations.

SUNOCO Richardson
Good time 59.1 Hours/Week (Average)
Attempted to run time 60.8 Hours/Week (Average)
Operating ratio 0.972
Above figures based on period 1 Aug 60 to 2 Sep 60
Time is not available for rent to outside organizations.

Vitro Labs
Good time 36 Hours/Week (Average)
Attempted to run time 38 Hours/Week (Average)
Operating ratio 0.947
Above figures based on period 1 Jul 59 to 1 Jul 60
Time is available for rent to outside organizations.

Pacific Union College
Good time 48 Hours/Week (Average)
Attempted to run time 47.5 Hours/Week (Average)
Operating ratio 0.99
Above figures based on period from Dec 58 to May 60
Time is available for rent to qualified outside organizations.

Pomona College
Good time 30 Hours/Week (Average)
Attempted to run time 30.5 Hours/Week (Average)
Operating ratio 0.98
Above figures based on period from Sep 58 to present
Passed Customer Acceptance Test Sep 58
Time is available for rent to outside organizations.

Texas Western
Good time 36-40 Hours/Week (Average)
Operating ratio 0.96
Above figures based on period from Feb 59 to Apr 60
Time is available for rent to outside organizations.

Univ of Del
Good time 55 Hours/Week (Average)
Attempted to run time 57 Hours/Week (Average)
Operating ratio 0.96
Above figures based on period from Sep 57 to Aug 60
Passed Customer Acceptance Test 15 Sep 57
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include low cost, expandability through such accessories as magnetic tape, punch card, paper tape units, plotter, etc., reliability (better than 95% average uptime for all units installed), fast delivery, access to hundreds of programs through users exchange organization, applicability for both business and scientific problems, and nationwide service facilities.

Unique system advantages include simplified programming systems like Intercom, Pogo, Autopoint, Algebraic Compiler, etc., expansion simplified by merely plugging accessories into the back of the computer, all input, output is fully buffered, permitting computation during input-output operations, and alphanumeric input-output.

USA C and G SC

The "Intercom 1000" system has been devised by Bendix as a programming system that can be learned in two days. It takes care of decimal point location and provides simple control over various machine functions.

The machine hardware of the G-15 contains a most versatile and powerful command structure. Coupled with this is one of the most completely buffered input-output systems offered on any computer.

Magnetic tape labelling is not a problem, since only one or two tapes are used. Paper tape program storage is handled by labeled storage boxes. Duplicate tapes are kept in a fire proof vault. This includes paper tape copies of data on magnetic tape.

We have found the computer easy to use and operate. Maintenance of the machine is handled from Kansas City, Missouri, which is about forty-five miles distant. Service has been very prompt, and the machine is well maintained.

USA Eng LAD

Outstanding features include flexibility in programming.

USA MS

Outstanding features include very versatile programming features in machine language and very simple programming in interpreter-compiler system.

Unique system advantage is that it lends itself readily to open shop operation.

Master tapes of all programs are maintained in case of destruction of any operational tape.

USA Ord WSMR

Outstanding features: reliable, easy to program with interpretive routine.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include: placed over cooling tunnel for building air conditioning system and all electrical plugs are disconnected at night.

USN CS

Outstanding features are relatively easy to program, simple to operate, versatile, and expandable.

Labeled canned storage with operating instructions enclosed, copies of all programs filed and cross indexed.

USN EES

Outstanding features are interpretive system (Intercom 1000) can be learned in approximately 4 hours and there are also other interpretive and compiling systems available.

Unique system advantages are inexpensive and active users exchange organization.

Guards check computer room when computer runs unattended during the night and weekends.

USN MC Pt Mugu

Outstanding features include digital differential analyzer capabilities.

Ordinary storage facilities are used for storage of magnetic tape.

Michigan SHD

Outstanding feature is its low cost compared to the computer's capacity.

AiResearch

Outstanding features include flexibility of operation and low rental cost.

Unique system advantages are the variety of input-outputs accepted.

Bendix Systems

This machine has been modified to provide optional input-output from the drum storage to external registers. System enables real-time display of output data on cathode ray tube display unit.

Fellows

Outstanding features are small size, inexpensive, self-contained, fits into our Engineering Dept. routine easily.

Unique system advantages include ability to add peripheral equipment as needed. Reliability - machine often runs all night unattended on long problems.

No special procedures are in effect for tape storage. Tape is left on machine. Only one reel required for our problem.

Ford Instrument

Outstanding features are flexible command structure, convenient minimum access coding, low price (unfair to compare with more modern systems). Just about outdated by newer Bendix and other manufacturers' models, but still good.

Hercules Powder

Outstanding features include flexibility, variety of input-output equipment.

International Harvester

We are extremely pleased with the acceptance within our group of the open shop type operation.

Humble Oil

Outstanding features are low unit computing cost for machine in this price range. Excellent reliability.

The Martin Company Baltimore

Only two reels of magnetic tape are used. These are installed in magnetic tape units.

North American

Unique system advantages are computing and control simultaneous with magnetic tape and card operation. INTERCARD, a floating point interpretive system provides 500 seven-digit numbers/min input speed and 400/min. output speed. Off-line monitors for unattended night operation are used successfully.

Vitro Labs

Outstanding feature is that output proceeds while computation progresses. Programming may be done by the interpretive system or basic machine language.

Pomona College

Excellent small computer, simple to use.

Texas Western

Outstanding features are command structure is extremely flexible, two address command permits true minimum access coding, double length arithmetic registers permits programming of double-precision operations, and reduction in computation time by incorporating arbitrary precision multiplication and division in the design.

FUTURE PLANS

USA AMS

Intend to obtain a Field Artillery Digital Automatic Computer (FADAC) (rugged, lightweight computer for use in the field with artillery units).

USA C and G SC

Continuation of present projects with a study to be conducted for additional uses within the College.

USA Eng LAD

The present system is considered to be adequate for the present and foreseeable engineering needs of the District. Expansion of this system or acquisition of another system to accomplish data processing outside of the engineering field may occur in the future.

USA MS

Acquisition of tape preparation and verification system. Possible acquisition of auxiliary magnetic tape unit if efficiency and savings will result.

USA Snow Ice Perma

Future needs anticiapted are a medium size computer with floating point hardware to increase operating speeds.

USN ADC

Research and Development Program to tie system into external equipment for simulation applications.

USN HO Suitland

Plan to add another unit of same type.

USN MC Pt Mugu

Future plans call for tying the G-15 to the Simulation Facility analog computer for simulating Navy weapons systems components. The purpose will be to analyze the weapons systems capabilities. Equipment for conversion from digital information to analog and vice versa is on order from Bendix.

US B of R

Addition of CA-1 Card Coupler with IBM 026 Key Punch for minor accounting application. Addition of tape preparation unit.

Michigan SHD

A second Bendix G15-D Computer has just been proposed to management.

Bendix Eclipse-Pioneer

We are presently considering the acquisition of the Bendix G-20, General Purpose Digital Computer. This computer can perform arithmetic operations approximately 2500 times faster than the G-15A.

Dow Chemical

Possibly of leasing punched card facilities in the future.

Fellows

A separate data handling system for payroll and accounting may be acquired in the future.

Ford Instrument

Plans call for continued use of present equipment.

International Harvester

The following equipment may be added to this system at a later date: Alphanumeric Typewriter, Graph Plotter, Digital Differential Analyzer, and Magnetic Tape Unit.

Humble Oil

A Bendix G-20 System is proposed for installation during the first quarter of 1961. Components for this system are shown in the following table.

1	Central Computer
1	Card Reader, 500/min.
1	Printer, 600 lines/min.
5	Magnetic Tape Units
1	Coupler for IBM equipment
1	Auxiliary Memory
1	Buffer Control
1	Console
2	Auxiliary Magnetic Tapes

This machine will be shared with the Humble Division Petroleum Engineering Section of the Production Department and the Geologic Research Section of the Exploration Department. The proposed system will supplant IBM 704 time which is currently rented from service bureaus as well as some of the long problems done on our present system.

The purpose of the system with expanded capacity is primarily to provide means of carrying out predictions and optimization of reservoir performance. It is planned to retain the G-15A for a time after installation of the G-20.

North American

Replacement of G-15D facility with one (1) G-20 Computer with 16,392 word core storage, four (4) magnetic tapes, card input-output and high-speed printer, add digital-analog converter.

Vitro Labs

Additional equipment planned is an analog computer.

Pacific Union College

We are in process of developing a magnetic core storage buffer which will enable magnetic tape units to read information into and out of the computer at drum speed. We believe this will be unique in so far as a medium speed computer in the Bendix G-15 class is concerned.

Pomona College

System will be expanded when need arises.

Texas Western

A new alphanumeric programming system will soon be received. There are plans for transformer design production problems in the near future.

Univ of Del

For the life of the present machine we will keep abreast of increasing needs by more efficient input-output and debugging procedures and, if necessary, additional peripheral equipment.

INSTALLATIONS

U. S. Army Artillery and Missile School
Computer Branch
Fort Sill, Oklahoma

U. S. Army Command and General Staff College
Fort Leavenworth, Kansas

U. S. Army Engineer District, Little Rock
P. O. Box 867
Little Rock, Arkansas

U. S. Army Engineer District, Los Angeles
751 South Figueroa Street
Los Angeles 17, California

U. S. Army Map Service
6500 Brooks Lane
Washington 25, D. C.

Frankford Arsenal - ORDBA-6230
Philadelphia 37, Pennsylvania

U. S. Army Ordnance Mission
White Sands Missile Range, New Mexico

U. S. Army Snow, Ice, Permaforst Research Establishment
1215 Washington Avenue
Wilmette, Illinois

U. S. Naval Air Development Center
Aeronautical Computer Laboratory
Johnsville, Pennsylvania

Bureau of Weapons
Department of the Navy
Washington 25, D. C.

Charleston Naval Shipyard
Charleston, South Carolina

U. S. Naval Engineering Experiment Station
Applied Math Office, Code 502
Annapolis, Maryland

U. S. Navy Hydrographic Office
Geodetic Computing Unit
Suitland, Maryland

U. S. Navy Mine Defense Laboratory
Navigation Branch
Panama City, Florida

U. S. Naval Missile Center
Systems Department
Point Mugu, California

U. S. Naval Supersonic Laboratory, M. I. T.
560 Memorial Drive
Cambridge, Massachusetts

U. S. Bureau of Reclamation
Regional Office, Region 4
32 Exchange Place
Salt Lake City, Utah

Illinois Division of Highways
State Office Building, Room 703
Springfield, Illinois

Michigan State Highway Department
Computer Unit
S. T. Mason Building
Lansing, Michigan

AiResearch Manufacturing Company of Arizona
402 South 36th Street
Phoenix, Arizona

Bendix Aviation Corporation
Eclipse-Pioneer Division
Teterboro, New Jersey

Bendix Radio
A Division of Bendix Aviation Corporation
Department of Research and Development
Towson 4, Maryland

Bendix Systems Division
The Bendix Corporation
3300 Plymouth Road
Ann Arbor, Michigan

Dow Chemical Company
Engineering Department, Bldg. B-1201
Freeport, Texas

Ebasco Services Inc.
2 Rector Street
New York 6, New York

Fellows Gear Shaper Company
River Street
Springfield, Vermont

Ford Instrument Company
31-10 Thomson Avenue
Long Island City 1, New York

General Mills, Inc.
2003 E. Hennepin Avenue
Minneapolis 13, Minnesota

Hercules Powder Company
Applied Mathematics Division
Wilmongton 99, Delaware

International Harvester Company
Engineering Research
5225 So. Western Blvd.
Chicago 9, Illinois

Humble Oil and Refining Company
Humble Division
P. O. Box 2180
Houston 1, Texas

Lockwood, Kessler & Bartlett, Inc.
One Aerial Way
Syosset, New York

The Martin Company
Manufacturing, Engineering & Research Dept.
Baltimore 3, Maryland

North American Aviation, Inc.
Missile Division
12214 Lakewood Boulevard
Downey, California

The Ohio Oil Company
Refining Division
Robinson, Illinois

RCA Service Company
Data Processing, AFMTC, Bldg. 989
Patrick Air Force Base, Florida

Sun Oil Company
Reservoir Analytical Section
1096 Calder Avenue
Beaumont, Texas

Sun Oil Company
503 N. Central Expressway
Richardson, Texas

Vitro Laboratories
200 Pleasant Valley Way
West Orange, New Jersey

Pacific Union College
Data Processing Laboratory
Angwin, California

Pomona College
Physics Laboratory
Claremont, California

Texas Western College
Schellenger Research Laboratory
El Paso, Texas

University of Delaware
Computing Center, Evans Hall
Newark, Delaware

BENDIX G20

Bendix G 20 General Purpose Data Processing System

MANUFACTURER

Bendix Computer Division
Bendix Aviation Corporation

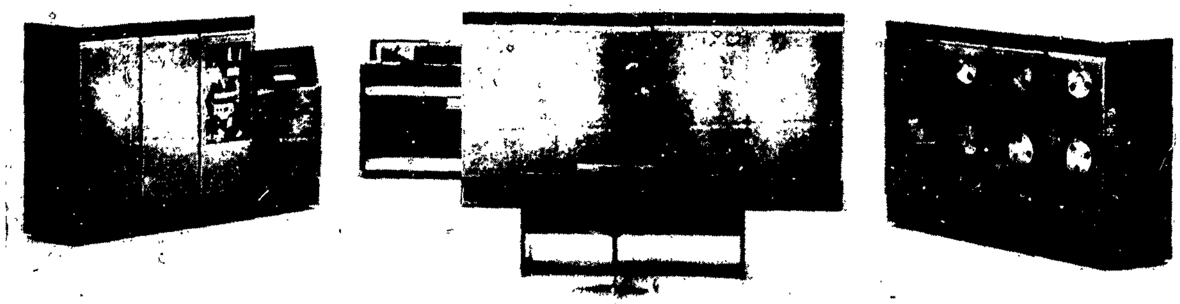


Photo by the Bendix Computer Division

APPLICATIONS

The completely modular construction of the G-20 system permits the creation of general purpose commercial data processing, general purpose scientific computing, off-line, on-line, or real-time systems by appropriate selection and interconnection of modules.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	32 + 1 parity bit
Binary digits/instruction	32 + 1 parity bit
Instructions per word	1
Instructions decoded	63 for central processor
Arithmetic system	Floating point
Instruction type	One address
Number range	$\pm 10^{-57}$ to $\pm 10^{69}$

Instruction word format

Flags	Mode Code	Operation Code	Index	Base Address
31 30	29 28	27 21	20 15	14 0

Automatic built-in subroutines include fixed point arithmetic and storage, 63 index register and associated operation codes, automatic repeatable commands (32 in number), can be repeated any desired number of times, interrupt request hardware, and clock interrupt (1 per sec.).

Automatic coding includes Symbolic Program and Assembly Routine, Algebraic Compiler, Executive Routine, Report Generator, Sort Routines, File Maintenance Routine, and Commercial Compiler.

Registers and B-boxes include 63 memory locations used as Index locations (Built-in Index Registers), interrupt and control registers, and a fixed point exponent register.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	27	13
Mult	70	56
Div	112	98

Construction (Arithmetic unit only)	
Transistors	5,000 approx.
Diodes	30,000 approx.
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4,096 to 32,768	28,672 to 1,081,344	8.4

Magnetic Tape	
No. of units that can be connected	Any number Units
No. of char/linear inch of tape	550 Char/inch
Channels or tracks on the tape	10 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	110 or 220 Inches/sec
Transfer rate	60,000 Char/sec
Start time	4 Millisec
Stop time	4 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	1 Inch
Length of reel	3,600 Feet

INPUT

Media	Speed
Paper Tape	500 char/sec
Cards	650 cards/min
Control Console (type)	Manual
Magnetic Tape	60,000 char/sec

Characters are 8 bits.

OUTPUT

Media	Speed
Paper Tape	100 char/sec
Cards	250 cards/min
Printer	600 lines/min
Magnetic Tape	60,000 char/sec

Characters are 8 bits. Printer is up to 120 characters wide.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	240
Diodes	38,000
Transistors	8,900
Magnetic Cores	173,000 - 1,081,344

The entire system could range from a central processor and control console with typewriter to a large data system, with many magnetic tape and card units.

The above information considers the entire system as a central processor, control console, four magnetic tape units, a magnetic tape control unit, a card and printer coupler, a high speed printer and a control buffer.

CHECKING FEATURES

Checking features include parity check in central processor (to and from memory), parity check on all input-output equipment, and parity check, parity bit recorded and automatic read immediately after writing.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	3.5 KVA	0.9 pf
Volume, computer	67.5 cu ft	
Area, computer	12.7 sq ft	
Floor loading	24,000 lbs/sq ft	
	753 lbs concen max	
Weight, computer	2,000 lbs	

A plenum can be used for air intake from underneath.

No rear access is needed for Central Processor.

All accessory units - subfloor air cooling advisable, but air intake can be from the back as well as the underside.

Minimum rear access to accessories is 24 inches.

Air conditioner to maintain 65° - 80°F ambient temperature.

PRODUCTION RECORD

Time required for delivery   Approx. 15 months

COST, PRICE AND RENTAL RATES

G-20 and Accessory Price List		Purchase	Monthly Maint. for Purchased Equipment	Lease per Month
G-20	Processor, including 4,096 words of core memory	$ 290,000	$ 1,210	$ 6,500
MM-10	Auxiliary Core Memory of 4,096	55,000	230	1,650
MC-10	Auxiliary Core Memory of 4,096 words & Control Feature	110,000	460	3,300
CC-10	Control Console Station, including alphanumeric input-output monitor typewriter	10,000	45	300
TC-10	Magnetic Tape Control Unit - necessary for control of from one to four tape units	30,500	130	915
MT-10	High Speed Magnetic Tape Unit	28,500	120	855
LP-10	Line Printer (72 characters) (needs CP-10)	28,700	120	860
LP-11	Line Printer (120 characters) (needs CP-11)	68,300	285	2,050
CP-10	Adapter for Card and Tabulator Equipment (80 column)	22,500	95	675
CP-11	Adapter for Card and Tabulator Equipment (120 column)	27,500	115	825
CB-10	Buffer Control Station	50,000	210	1,500
PT-10	Paper Tape Input-Output Station, including a paper tape reader (500 characters per second) and a paper punch (100 characters per second)	17,500	75	525

The cost of maintenance for punched equipment on the G-20 Central Processor and all accessory equipment is given above, along with purchase price and lease rate. The minimum contract will be (1) one year.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	2	3
Analysts	2	4	5
Programmers	6	8	10
Coders	4	8	12
Clerks	0	1	1
Operators	1	2	3
In-Output Oper	0	0	1

Personnel required will vary from installation to installation due to type of application, i.e. third shift may be used unattended with one operator. Figures are for a minimum lease system.

ADDITIONAL FEATURES AND REMARKS

The addressing facilities allow the programmer to operate on the address, the contents of the address or the contents of the contents of the address with every command.

Prior to and after computation, information may be available with the decimal point in any prespecified digit position-for work in dollars and cents, etc.

Control buffers, which control input/output separate from the central processor, may be added to the systems.

INSTALLATIONS

Bendix Computer Division, Bendix Aviation Corporation, 5630 Arbor Vitae Avenue, Los Angeles 45, California

Bendix Aviation Corp., Research Laboratories Div., P.O. Box 5115, Detroit 35, Michigan

BIZMAC I

Radio Corporation of America BIZMAC System Model I

MANUFACTURER

Radio Corporation of America

Picture by Ordnance Tank-Automotive Command

APPLICATIONS

Demand History File - A file containing demand and issue data for approximately 100,000 items of supply. This process involves accumulating and recording for each item in the file one year's demand and issue activity.

Frequency of File Maintenance: Bi-Weekly

Availability Balance File - A magnetic tape file containing asset and level information both summarized and separated as to location for approximately 123,000 items. The processing of stock status information provides an up-to-date file of supply information for all items which are recognized as OTAC responsibility. This file also provides the capability of editing requisitions by machine and is also used for statistical analysis of inventory.

Frequency of File Maintenance: 3 Days

Financial Inventory Analysis - A process that provides for analysis of the asset position of each item in the Availability Balance File and provides management with necessary information from which to prepare required financial reports. Assets and levels are converted into dollar figures and assets are applied against levels in established priorities.

Frequency of File Maintenance: Quarterly

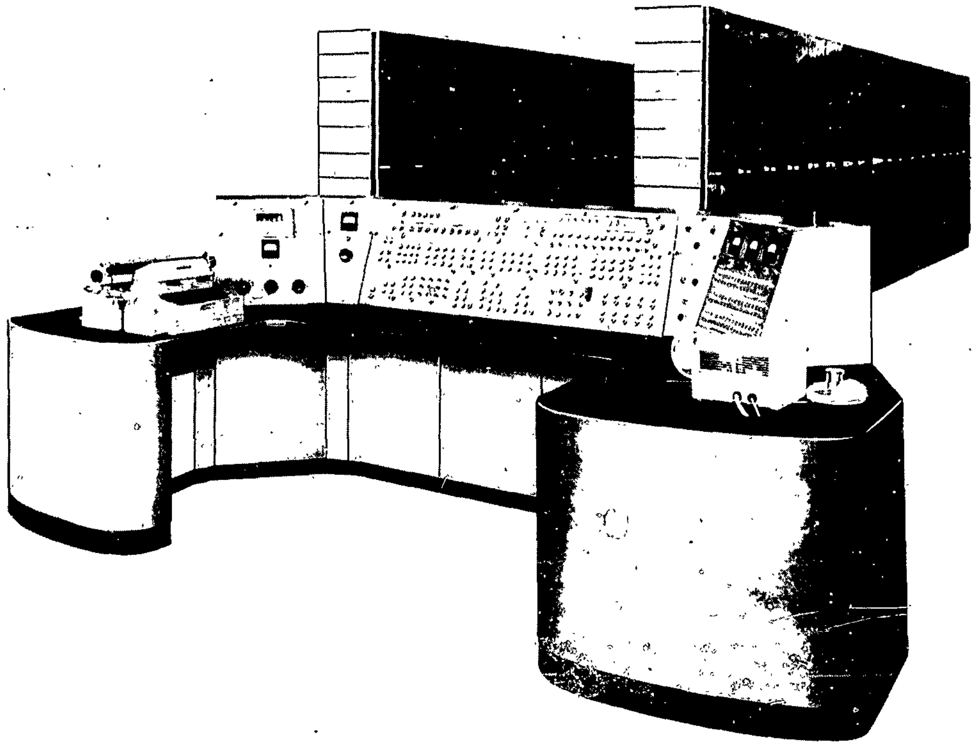
Vehicle Parts File - Maintenance of a file containing about 300,000 messages of repair parts, tools, equipment items, and special notes, arranged in end-item designation sequence.

Frequency of File Maintenance: Weekly

Type 3 Supply Manual - Maintenance of a file containing about 1,250,000 messages of a cross-reference between Federal Stock Numbers (FSN) and reference numbers, including repair-part identifying numbers and previously assigned stock numbers that were withdrawn. The record is maintained in FSN sequence for all Ordnance managed repair parts.

Frequency of File Maintenance: As required

Above applications are being made by the U. S. Army Ordnance Tank-Automotive Command.



COMPUTER - Picture by Radio Corporation of America

PROGRAMMING AND NUMERICAL SYSTEM

Arithmetic system	Fixed point
Instruction type	Three address

Data are organized in the RCA BIZMAC System in the following manner:

Seven bits (6 information + 1 parity) comprise one BIZMAC character (63 characters including ten decimal digits, 26 letters, control symbols, and miscellaneous symbols). A variable number of related characters preceded (on the left) by a control symbol comprises an item (corresponding to a word).

A group of related items enclosed by control symbols is a message (for handling as a unit on tape).

An instruction consists of eight BIZMAC characters interpreted as follows:

Operation	Variation	Addresses		
		A	B	C
B	B	BB	BB	BB

There are twenty-four basic operations which may be varied by the variation character to obtain approximately 140 distinct combinations.

The computer may perform decimal and binary arithmetic operations. Operands are completely variable in length. A 32-character operand limitation is necessary in decimal addition and subtraction where an end-around carry is possible and in multiplication where the multiplicand is also restricted in the same manner.

ARITHMETIC UNIT

In arithmetic operations, the three addresses are used to specify the High Speed Memory locations of the least significant characters of the operands and the result. Execution time for each of these instructions is variable depending on the number of significant characters in the operands. Control symbols as well as space symbols to the left of operands cause the operations to end. The following timing formulae are available:

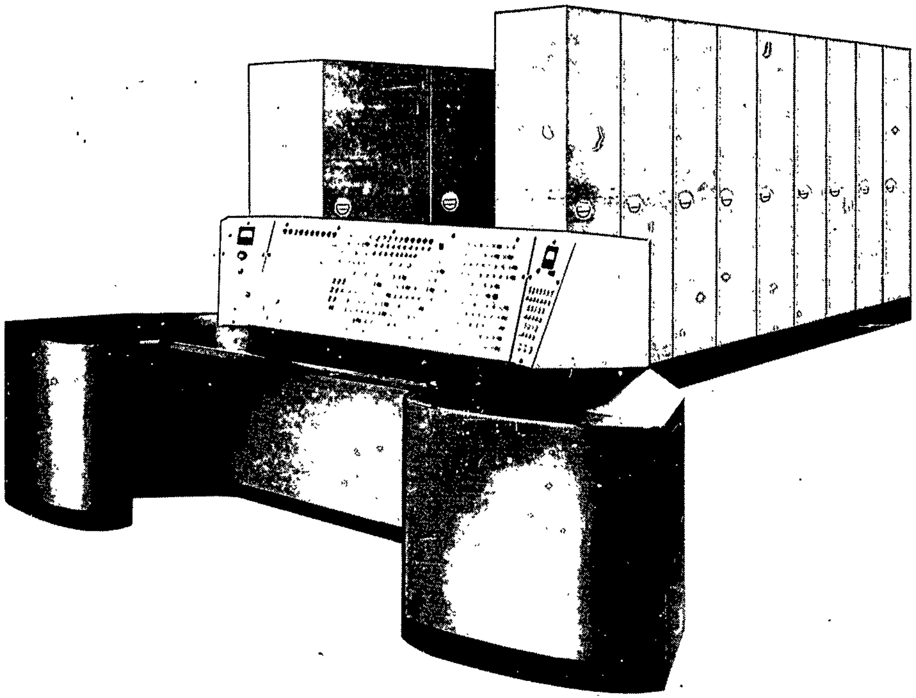
ADDITION TIME is given by 120 + 40C microseconds, where C equals number of characters in longest operand. This is the formula for addition with positive operands. Formula time is increased when the zero suppression or automatic left justification option is desired or if there is an end-around-carry.

MULTIPLICATION TIME is given by 160 + 288N + 145MN microseconds, where M = No. of digits in multiplicand N = No. of digits in multiplier.

The constants 288 and 145 in the above formula are average times for reading out characters, and repetitive additions are determined by the magnitude of the digits in the multiplier.

Division is programmed, and the time varies with the type of division program used, as well as with the characters of the operands.

The timing formulae shown above include instruction-staticizing time as well as transfer-of-data time to and from the memory.



SORTER - Picture by Radio Corporation of America

Basic construction of the arithmetic unit is vacuum tube-diode. There are no programmed rapid access registers outside of the 4,096-character High Speed Memory. Basic pulse-repetition rate is 500 KC throughout the Computer. Arithmetic operations are primarily serial although pairs of characters (one from each operand) are read from memory in parallel.

Construction	Magnetic cores and vacuum tubes
Timing	Synchronous for the computer Asynchronous for tape operation
Operation	Sequential by character Concurrent by 7 bits forming the character.

STORAGE

Media	Digits	Microsec Access
Magnetic Core	4,096	20
Magnetic Drum	18,000	5,120
Magnetic Tape	Indefinite	5,000

Random access to any character in core storage.
Characters may be transferred between magnetic drum storage in blocks of 4 or 8 at 80 microseconds per block.
Words are variable in length. Intermediate storage is magnetic tape. Read/write 10,000 char/sec. 125 char/in density, 7 bit code.

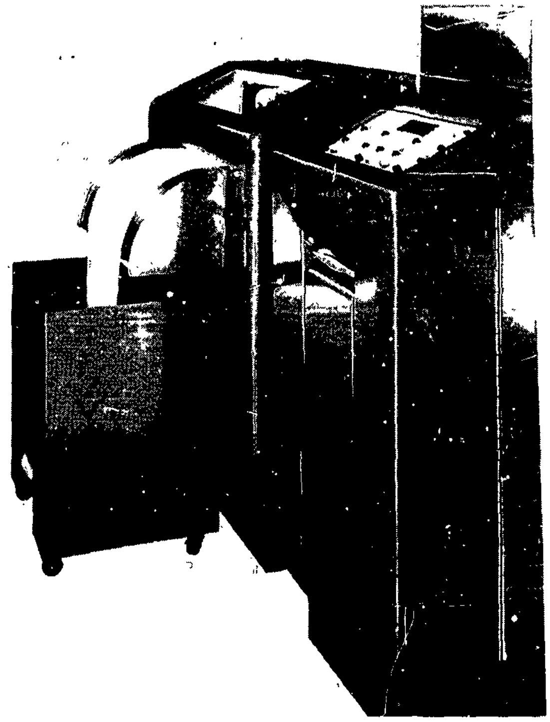
INPUT

Media	Speed
Card Transcriber (Card to Magnetic Tape)	375 cards/min
Tapewriter and Verifier (Key to Paper Tape)	5,000 strokes/hour
Paper Tape Transcriber (Paper to Magnetic Tape)	200 char/sec

Inputs to all data processing equipment via magnetic tapes are at 10,000 characters/sec with blanks eliminated by variable word length. Direct paper tape input to the computer is at 400 characters/sec.

OUTPUT

Media	Speed
Electromechanical Printer	300/600 lines/min 120 char/line
Magnetic Tape Transcriber (Magnetic to Paper Tape)	20 char/sec
Trancoded (Magnetic Tape to Teletype Tape)	50 char/sec
Document Printer (Paper Tape to Typewriter)	10 char/sec
Transcribing Card Punch (Magnetic Tape to Card)	150 char/min
Interrogation Unit (Magnetic Tape to Typewriter)	4 min/inquiry (average)



ELECTROMECHANICAL PRINTER - Picture by Radio Corporation of America

With the exception of monitor print (via on-line typewriter) the output of all high-speed data processing equipment is magnetic tape: 10,000 characters per second with blanks eliminated by variable word length.

The document printer prints upper and lower case directly from magnetic tape.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	5,000
Tube types	12
Crystal diodes	14,500
Magnetic cores	28,700

The above figures are for the Computer only. System figures depend on exact equipment complement.

Government Sample
Ordnance Tank-Automotive Command
System has the following complement:

Tubes	30,000
Crystal diodes	70,000
Magnetic cores	35,000
Transistors	200
Separate cabinets	470

CHECKING FEATURES

Parity

The BIZMAC code is designed in such a fashion that each character of information contains a redundant parity bit for even parity checking. The various devices in the system contain hardware for extensive utilization of this feature. In the Computer, information circulating internally or transferred to and from tape is checked for parity.

Adder Comparison

The adder forms two sums (the second by using complements of the operands). These sums must be equal, or comparator alarms are registered.

Tape Checks

Input checks are provided to assure that the proper sequence of control symbols is sensed (marking the beginning and end of messages). The first character read in is checked to see that it is one of three permissible control symbols.

An output check is provided by an echo signal, which is used to determine that writing on tape has properly taken place.

Dual recording on magnetic tape is provided. Fourteen channel tape permits the duplicate storage of each bit.

Program Control

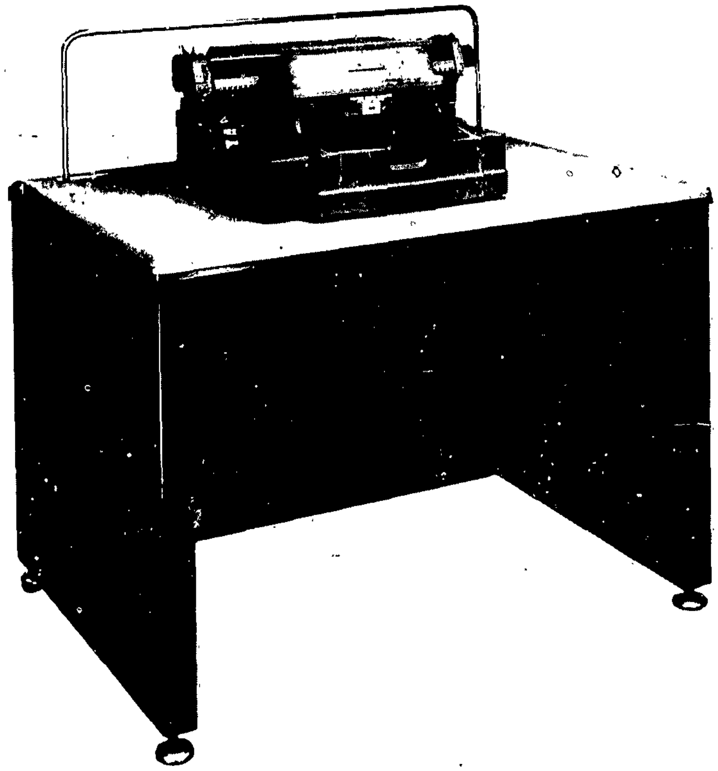
Checks are provided to insure that instructions are properly located, that drum switching is correctly completed, and that the flow of basic machine cycles is correct.

Instruction Characteristics

Facilities which are present for use in programs include a verify instruction for data comparison, and an overflow alarm usable with decimal arithmetic instructions.

Computer Stop-Rollback Switch

This device is used to reduce manual intervention when certain types of errors are detected: parity, adder comparison, programmed verify and overflow, control-symbol sequence incoming from tape. When the switch is in the rollback position a transfer of control will be made automatically to a specific



REMOTE PRINTER - Picture by Radio Corporation of America

drum line, permitting attempts to repeat the affected operation.

General

Only a partial listing of checking features is presented above. The RCA BIZMAC System makes extensive use of hardware checks to insure the proper operation of the system as a whole. Many of the checks are implicit in the design (e.g. no erase while reading) or explicit in special circuits (e.g. parity checking).

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Ordnance Tank-Automotive Command

Power, entire system	246 KW	274 KVA	0.9 pf
Power, air cond.	500 KW		
Volume, entire system	2,600 cu ft		
Area, entire system	20,000 sq ft		
Room size required	61 ft x 360 ft		
Weight, computer	26,500 lbs		
Floor loading	125 lbs/sq ft		
Capacity, air cond.	270 tons		
Volume, air cond.	1,200 cu ft		
Area, air cond.	100 sq ft		

False ceiling and pedestal floor in System Control Center. Accoustical walls necessary in high speed printer room. High temp. heads for sprinkler system. 270 ton air conditioning plant plus precipitrons.

COST, PRICE AND RENTAL RATES

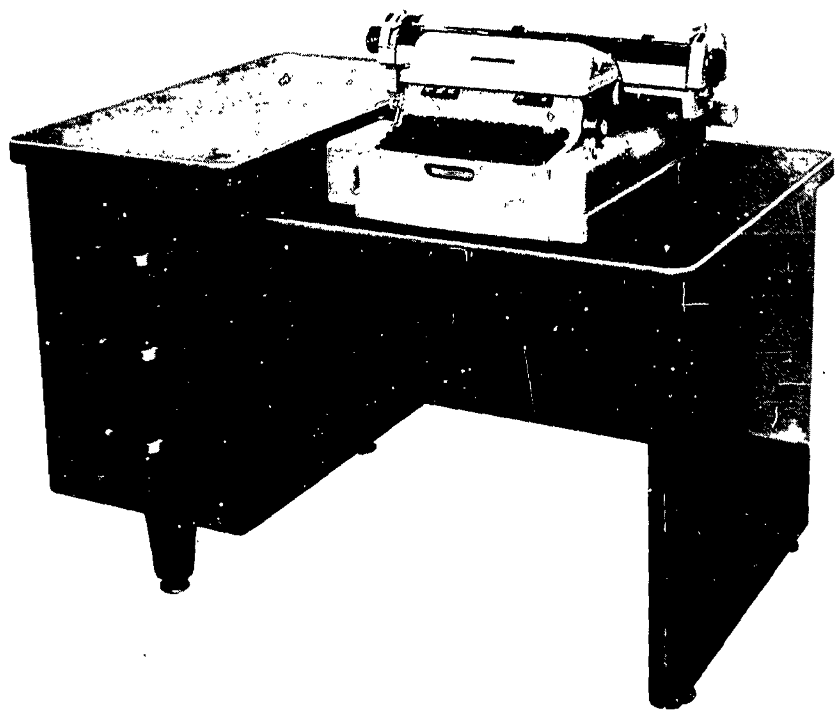
$4.5 million acquisition cost.
(1) Computer, (3) File Maint. computers (fixed program), (1) Interrogation Unit, (182) tape stations, (1) System Control Unit, (1) Card Transcriber, (1) Paper Tape Transcriber, (2) high speed printers, (1) Transcribing Card Punch, (3) Document Printers, (10) Flexo-writers.

RCA Service Bureau Contract for Maint. $514,000/year

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors	8	9
Analysts	7	0
Programmers	22	0
Clerks	4	3
Librarians	0	2
Operators	0	25
In-Output Oper	0	14
Tape Handlers	0	4

Operation tends toward modified "open" shop. Higher echelon positions of responsibility filled by upgrading. Personnel "pipe line" is filled at trainee level by necessity.



TYPEWRITER - Picture by Radio Corporation of America

Initially at manufacturer's plant in Camden, N.J.; later to be provided at site or plant as required. Programming and on-the-job operational training now conducted by Ordnance personnel at site.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Ordnance Tank-Automotive Command

Good time	98.29 Hours/Week (Average)
Operating Ratio (Good/ Attempted to run time	0.9928
Above figures based on period from Mar 60 to Jun 60	
Date this system passed customer acceptance test	Nov 55

Time is not available for rent to outside organizations.

Above calculations predicted on:
Total possible available system hours (minus actual machine downtime)
Example:

	377.9	Total Production Hours - April 1960 Actual Avail Hours
Less	9.4	Total Unscheduled Maint.
Less	13.2	Total Hours Idle (All Causes)
Less	20.5	Total Hours Spoiled word (All Causes)
	334.8	Total Hours Productive - Apr. 60 (Computer only)

ADDITIONAL FEATURES AND REMARKS

All equipment items in the RCA BIZMAC System are designed to accomodate actual data lengths.

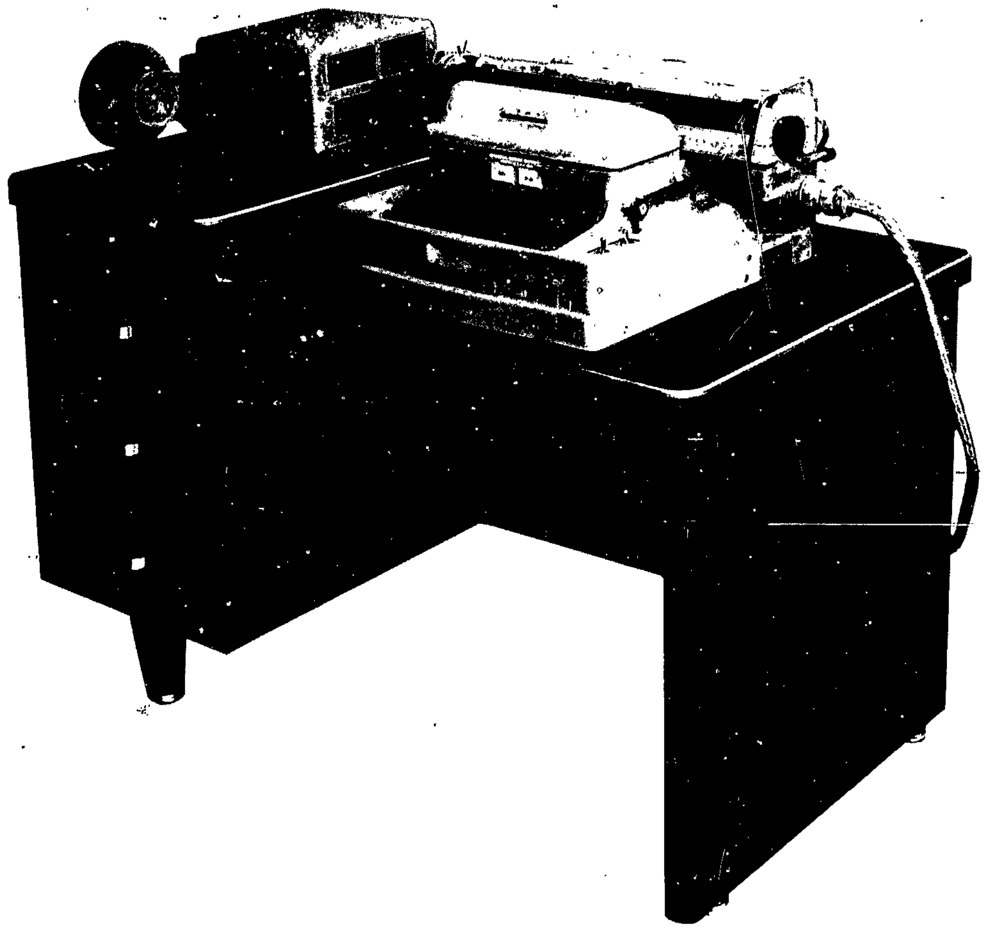
All equipment items in the RCA BIZMAC System are designed to permit equipment integration, i. e. central operation of all equipment including interconnection of Tape Stations and operating devices. This means of integration permits parallel operation of equipment items on "tight" schedule basis.

A separate equipment item, the Sorter, is provided to rearrange information on magnetic tape. It is provided to sort, merge and extract said information with provision for variations [illegible] these basic operations.

A separate equipment item, [illegible] Interrogation Unit, is an optional part of the system. [illegible] is a search and print-out device which permits [illegible] to any message stored on any Tape Station within the RCA BIZMAC System.

The BIZMAC Computer has definite operating advantages:

Random composition - read-in.
Random composition - write-out.
Full algebraic decimal add, subtract and multiply and binary add and [illegible] extract using variable length operands [illegible].
Magnetic tape [illegible] memory storage of programs with automatic prog. [illegible] from drum memory.
Automatic rollback function [illegible] permit correction of transient errors.
Three address instruction code with operating variations provided per instruction.



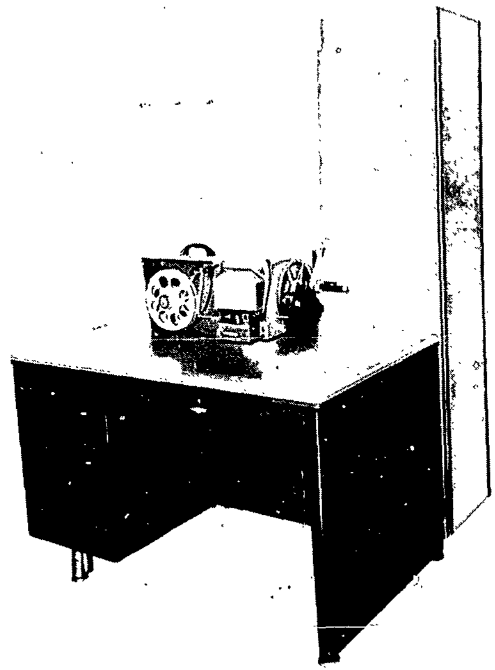
TAPEWRITER & VERIFIER (Key to Paper Tape) - Picture by Radio Corporation of America

Addressable character extract.
Linear-time-dependent transfer of data.
Automatic zero suppression.
Special instruction provision for handling subroutines.
Ability to write on tape while computing or reading (Simultaneous Write Instruction).
High speed paper tape input of 400 characters per second.
Fifteen addressable universal tape trunks, each can be used either as an input or output trunk.
Ability to read into High Speed Memory in compressed data form. (Linear Read).

Ordnance Tank-Automotive Command
Outstanding features include variable word length, absolute count control, and an interrogation unit.

Unique system advantages are that the interrogation unit permits rush interrogations at no loss of computer availability. It also permits data quality control check which minimizes re-run time. Electronic sorters preclude use of computer for non-essential processing. One hundred-eighty two tape stations permits maximum machine loading thru pre-scheduling.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage are those internal procedures that are in



TRANCODER (Magnetic Tape to Teletype Tape) - Picture by Radio Corporation of America

accordance with Department of the Army and Command directives.

INSTALLATIONS

Ordnance Tank-Automotive Command
Detroit 9, Michigan

FUTURE PLANS

Plans are being formalized to supplement existing system with the addition of one (1) RCA 501 System consisting of (1) Computer - 65K memory, eighteen (18) Tape Stations, one (1) card transcriber, one (1) transcribing card punch, one (1) high speed printer, one (1) tape selecting unit and one (1) tape switching unit. Part of the above system will be Government owned and the remainder will be leased from RCA.

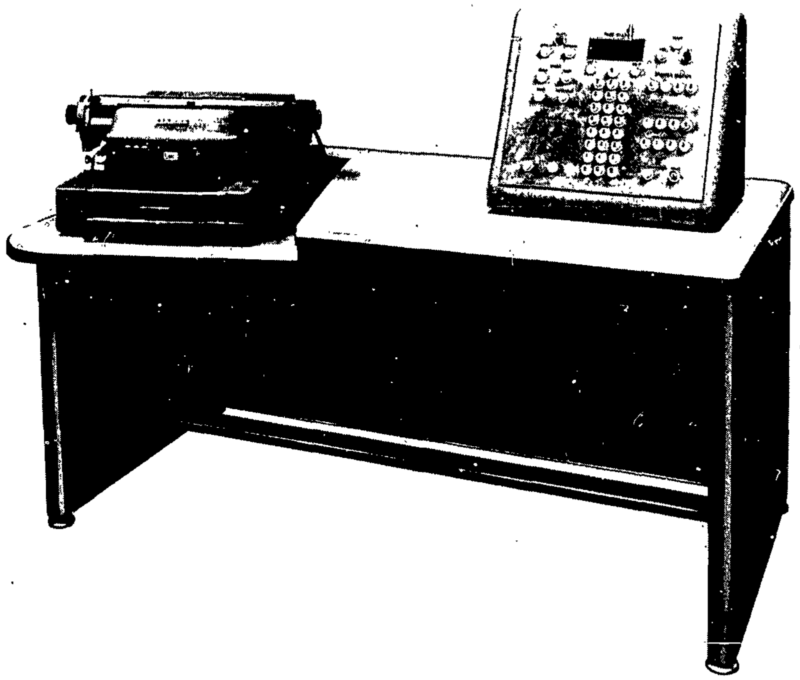
When the capacity of the new system has absorbed a major portion of the mark I process, it is planned that one (1) operating shift of the mark I will be phased out.

Task groups have been recently organized to study new applications for the other Directorates of this Command.

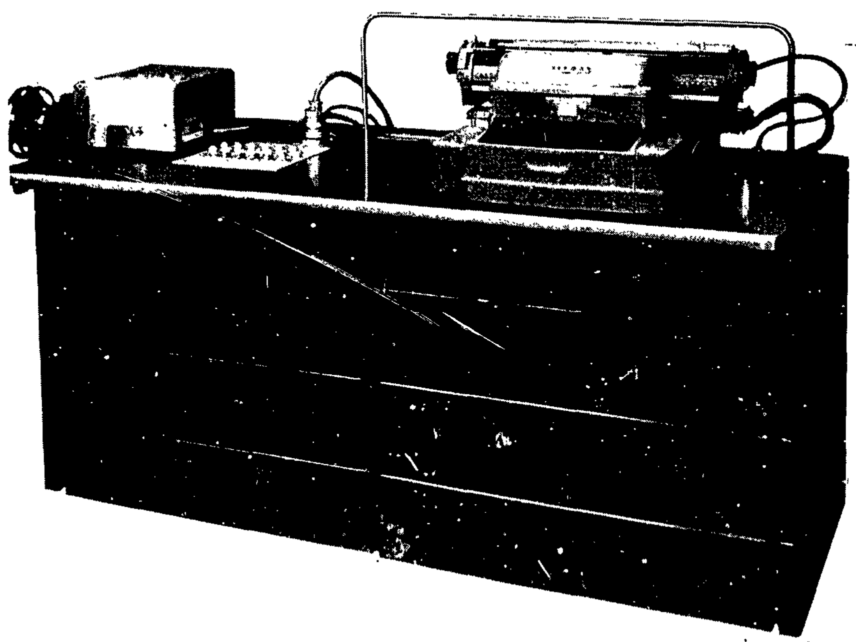
PRODUCTION RECORD

Produced	3
Operating	3

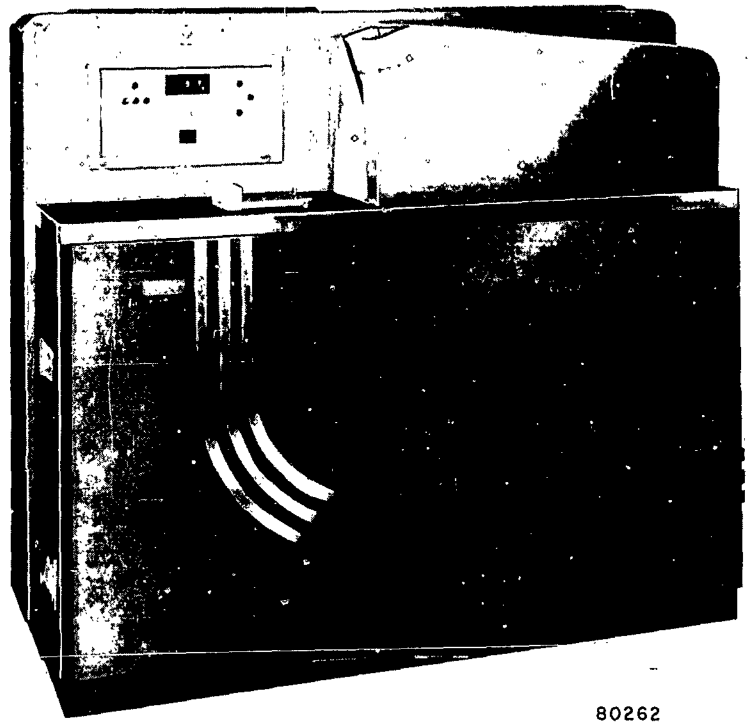
Above includes all early BIZMAC models.



Interrogation Unit (Magnatic Tape to Typewriter) Photo by Radio Corporation of America



Document Printer (Paper Tape to Typewriter) Photo by Radio Corporation of America



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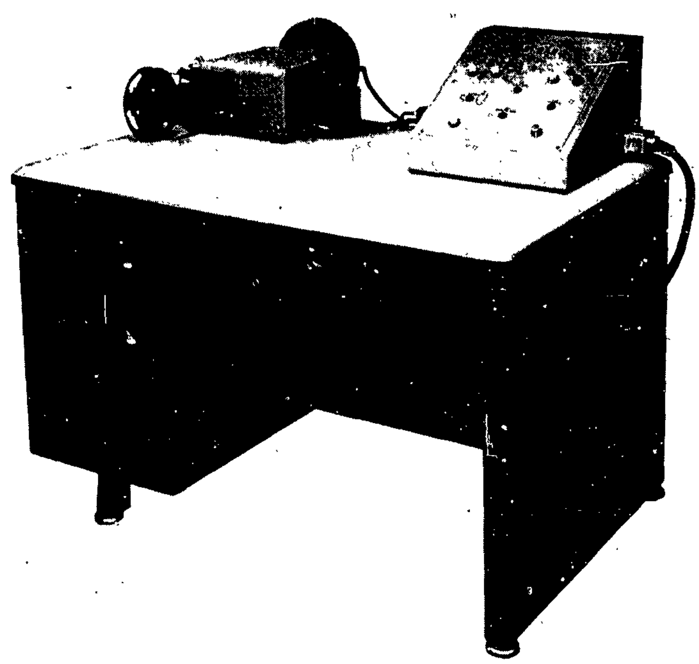
Card Transcriber (Card to Magnetic Tape) Photo by Radio Corporation of America



Magnetic Tape Transcriber (Magnetic to Paper Tape) Photo by Radio Corporation of America

BIZMAC II

BIZMAC II

MANUFACTURER

Radio Corporation of America

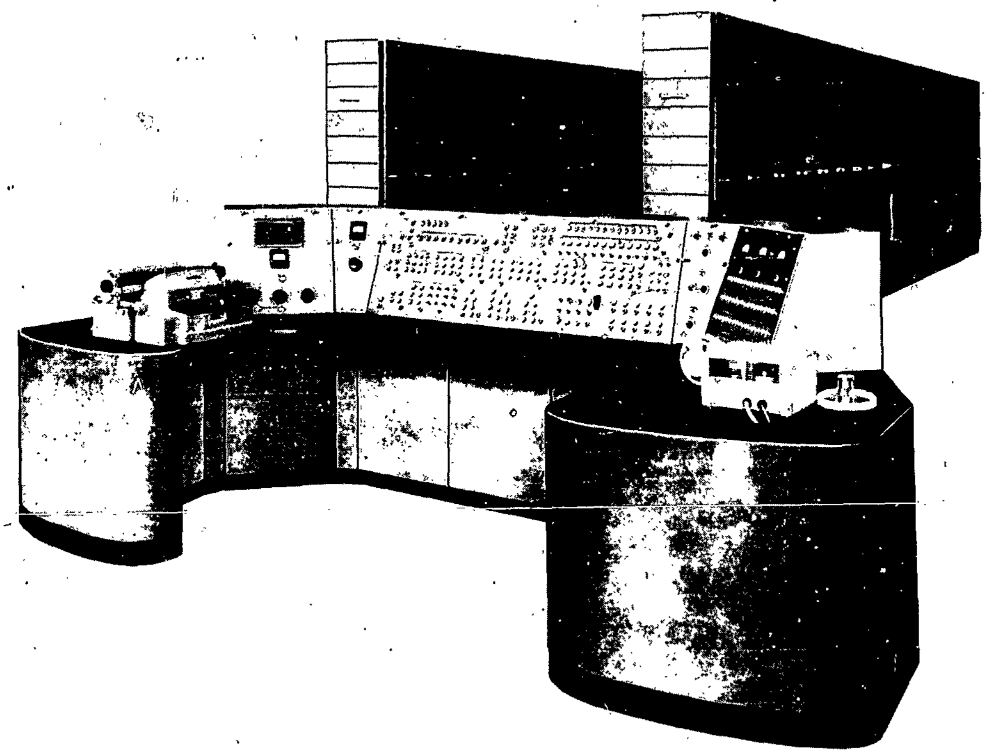


Photo by Radio Corporation of America

APPLICATIONS

Located at the EDP Center, Electronic Data Processing Division, RCA, Camden, New Jersey, the system is used for engineering desing, automated design of wiring for electronic equipment, accounting, statistical analysis, medical research, market research - automated logic, and management controls and clerical automation.

PROGRAMMING AND NUMERICAL SYSTEM

Arithmetic system	Fixed point
Instruction type	Three address

Data are organized in the BIZMAC II System in the following manner:

Seven bits (6 information + 1 parity) comprise one BIZMAC character (63 characters including ten decimal digits, 26 letters, control symbols, and miscellaneous symbols). A variable number of related characters preceded (on the left) by a control symbol comprises an item (corresponding to a word).

A group of related items enclosed by control symbols is a message (for handling as a unit on tape).

An instruction consists of eight BIZMAC characters interpreted as follows:

Operation	Variation	Addresses		
		A	B	C
B	B	BB	BB	BB

There are twenty-four basic operations which may be varied by the variation character to obtain approximately 140 distinct combinations.

The computer may perform decimal and binary arithmetic operations. Operands are completely variable in length. A 32-character operand limitation is necessary in decimal addition and subtraction where an end-around carry is possible and in multiplication where the multiplicand is also restricted in the same manner.

ARITHMETIC UNIT

In arithmetic operations, the three addresses are used to specify the high speed memory locations of the least significant characters of the operands and the result. Execution time for each of these instructions is variable depending on the number of significant characters in the operands. Control symbols as well as space symbols to the left of operands cause the operations to end. The following timing formulae are available:

ADDITION TIME is given by 120 + 40C microseconds, where C equals number of characters in longest operand. This is the formula for addition with positive operands. Formula time is increased when the zero suppression or automatic left justification option is desired or if there is an end-around-carry.

MULTIPLICATION TIME is given by 160 + 288N + 145MN microseconds, where M = No. of digits in multiplicand N = No. of digits in multiplier.

The constants 288 and 145 in the above formula are average times for reading out characters, and repetitive additions are determined by the magnitude of the digits in the multiplier.

Division is programmed, and the time varies with the type of division program used, as well as with the characters of the operands.

The timing formulae shown above include instruction-staticizing time as well as transfer-of-data time to and from the memory.

Basic construction of the arithmetic unit is vacuum tube-diode. There are no programmed rapid access registers outside of the 8,192-character high speed memory. Basic pulse-repetition rate is 500 KC throughout the computer. Arithmetic operations are primarily serial although pairs of characters (one from each operand) are read from memory in parallel.

Construction	Magnetic cores and vacuum tubes
Timing	Synchronous for the computer Asynchronous for tape operation
Operation	Sequential by character Concurrent by 7 bits forming the character

STORAGE

Media	No. of Alpha Char	Access Microsec
Magnetic Core	8,192	20/char
Magnetic Drum	32,736	5,120
Magnetic Tape	Indefinite	5,000

INPUT

Media	Speed
Card Transcriber	400 char/min
Tapewriter & Verifier	Operator limited
Paper Tape	200 char/sec

OUTPUT

Media	Speed
Electro-mechanical Printer (off-line)	600 lines/min
Document Printer	9 char/sec
Transcribing Card Punch	150 cards/min
Interrogation Unit	4 min/avg inquiry

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	5,000
Tube types	12
Crystal diodes	14,500
Magnetic cores	28,700

The above figures are for the computer only. System figures depend on exact equipment complement.

CHECKING FEATURES

Parity

The BIZMAC code is designed in such a fashion that each character of information contains a redundant parity bit for even parity checking. The various devices in the system contain hardware for extensive utilization of this feature. In the computer, information circulating internally or transferred to and from tape is checked for parity.

Adder Comparison

The adder forms two sums (the second by using complements of the operands). These sums must be equal, or comparator alarms are registered.

Tape Checks

Input checks are provided to assure that the proper sequence of control symbols is sensed (marking the beginning and end of messages). The first character read in is checked to see that it is one of three permissible control symbols.

An output check is provided by an echo signal, which is used to determine that writing on tape has properly taken place.

Dual recording on magnetic tape is provided. Fourteen channel tape permits the duplicate storage of each bit.

Program Control

Checks are provided to insure that instructions are properly located, that drum switching is correctly completed, and that the flow of basic machine cycles is correct.

Instruction Characteristics

Facilities which are present for use in programs include a verify instruction for data comparison, and an overflow alarm usable with decimal arithmetic instructions.

Computer Stop-Rollback Switch

This device is used to reduce manual intervention when certain types of errors are detected: parity, adder comparison, programmed verify and overflow, control-symbol sequence incoming from tape. When the switch is in the rollback position a transfer of control will be made automatically to a specific drum line, permitting attempts to repeat the affected operation.

General

Only a partial listing of checking features is presented above. The RCA Bizmac System makes extensive use of hardware checks to insure the proper operation of the system as a whole. Many of the checks are implicit in the design (e.g. no erase while reading) or explicit in special circuits (e.g. parity checking).

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	37.2 Kw	50.9 KVA
Power, air cond	5.0 Kw	7.5 KVA
Volume, computer		2,600 cu ft
Volume, air conditioner		1,200 cu ft
Area, computer		325 sq ft
Area, air conditioner		100 sq ft
Room size, computer		5,000 sq ft (entire system)
Room size, air conditioner		100 sq ft
Capacity, air conditioner		15 Tons
Weight, computer		26,500 lbs

Plenum. Unit wiring overhead.

PRODUCTION RECORD

Number produced	3
Number operating	3

See BIZMAC I

COST, PRICE AND RENTAL RATES

(1) Computer, (3) file maint. computers (fixed program), (1) interrogation unit, (182) tape stations, (1) system control unit, (1) card transcriber, (1) paper tape transcriber, (2) high speed printers, (1) transcribing card punch, (3) document printers, (10) Flexo-writers for the BIZMAC I cost $4,500,000 to acquire. Maintenance service on BIZMAC I is done by computer installation personnel.

PERSONNEL REQUIREMENTS

	Three 8-Hour Shifts
Supervisors	5
Analysts	3
Programmers	4
Coders	14
Clerks & Secretary	2
Librarians	0
Operators	4
Engineers	0
Technicians	1
In-Output Operators	4

Operation tends toward closed shop.

Methods of training used is a combination of formal instruction and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Good time	102.7 Hours/Week (Average)
Attempted to run time	104.73 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.98

Above figures based on period 1 Jan 60 to 30 Jun 60

Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Outstanding features are interrogation unit, a direct on-line paper tape input to computer at 400 char/sec, dual recording on tape, and variable word and message lengths.

Standard security procedures for handling magnetic tape have been adopted.

INSTALLATIONS

Electronic Data Processing Division
Camden EDP Center
Camden, New Jersey

BOGART

Bogart Computing System

MANUFACTURER

Remington Rand Univac
Division of Sperry Rand Corporation

APPLICATIONS

Department of Defense
Located at Fort George G. Meade, Maryland, the system is used for mathematical calculations by the Department of Defense.

STORAGE

Department of Defense

Medium	No. of Words
Magnetic Core	4,096

INPUT

Department of Defense

Media	Speed
Paper Tape (Ferranti)	400 frames/sec
Magnetic Tape (IBM 727)	75 inches/sec
Flexowriter	Manual

OUTPUT

Department of Defense

Media	Speed
Paper Tape	60 frames/sec
Magnetic Tape (IBM 727)	75 inches/sec
Flexowriter	10 char/sec

PERSONNEL REQUIREMENTS

Department of Defense

	One 8-Hour Shift
Supervisors	1
Operators	1
Engineers	1
Technicians	1

Operation tends toward closed shop.
Formal class and on-the-job training is given.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Department of Defense

Good time 38 Hours/Week (Average)
Attempted to run time 38.4 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.989
Above figures based on period 1 Dec 59 to 31 Dec 59
Time is not available for rent to outside organizations.

INSTALLATIONS

Fort George G. Meade, Maryland

BRLESC

Ballistic Research Laboratories Electronic Scientific Computer

MANUFACTURER

Ballistic Research Laboratories

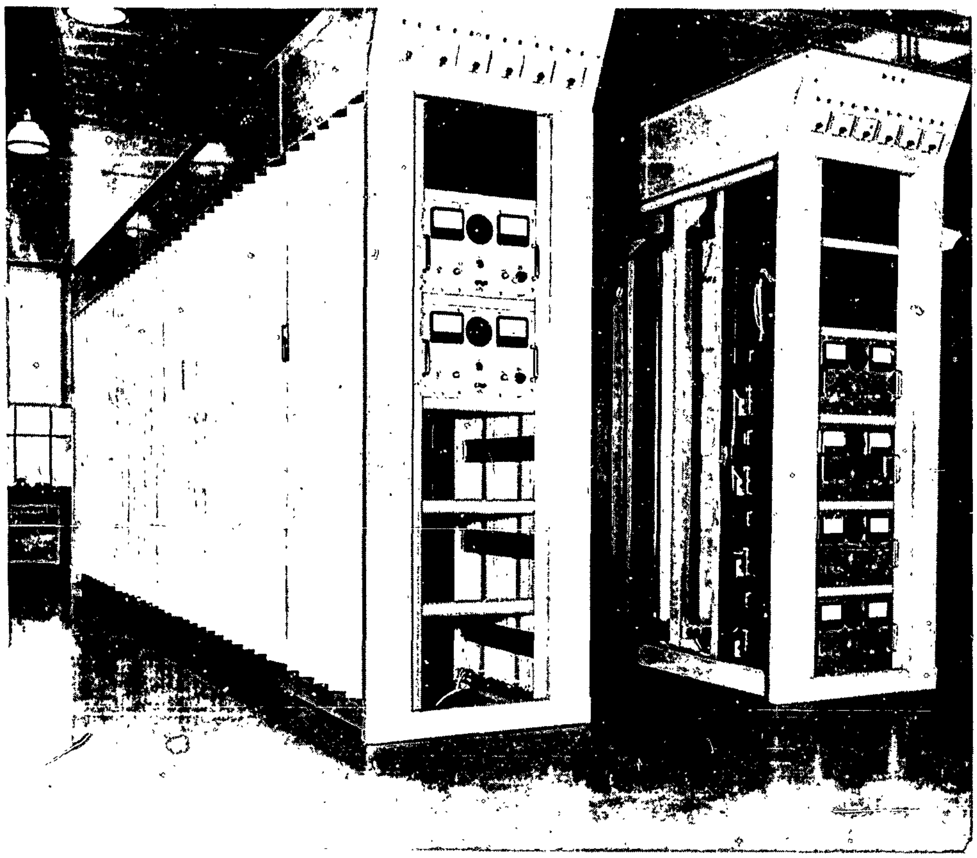


Photo by U. S. Army

APPLICATIONS

Exterior ballistics problems such as high altitude, sòlar and lunar trajectories, computation for the preparation of firing tables and guidance control data for Ordnance weapons, including free flight and guided missiles.

Interior ballistic problems, including projectile, propellant and launcher behavior, e.g. physical characteristics of solid propellants, equilibrium composition and thermodynamic properties of rocket propellants, computation of detonation waves for reflected shock waves, vibration of gun barrels and the flow of fluids in porous media.

Terminal ballistic problems, including nuclear, fragmentation and penetration effects in such areas as explosion kinetics, shaped charge behavior, ignition, and heat transfer.

Ballistic measurement problems, including photogrammetric, ionospheric, and damping of satellite spin calculations, reduction of satellite doppler tracking data, and computation of satellite orbital elements.

Weapon systems evaluation problems, including antiaircraft and nati-missile evaluation, war game problems, linear programming for solution of Army logistical problems, probabilities of mine detonations, and lethal area and kill probabilities of mine detonations, and lethal area and kill probability studies of missiles.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	68 + 4 parity
Binary digits/instruction	68
Instructions/word	1
Instructions decoded	33
Arithmetic system	Fixed and floating point
Instruction type	Three-address

Instruction word format

4	4	6	14	6	14	6	14
Order type	Parameter	Index	α-Address	Index	β-Address	Index	γ-Address

Number word format Fixed Point

3	1	4 .	60
Tag	Sign	Binary Point	

Number word format Floating Point

3	1	4 .	52	8
Tag	Sign	Binary Point	Coefficient	Biased Exp of 16

Automatic built-in subroutines
In addition to the standard set of jump instructions, three more jump instructions have been included which will be used in connection with the "permanent" storage of "built-in" subroutines. These are Jump to "permanent" instruction, Jump to "built-in" subroutine, and Set index and jump to main memory.

Registers and B-boxes
The machine will have 63-one microsecond access index registers, addressable by the α, β, and γ addresses of the instruction words.
The parameter bits of the instruction word are used to indicate variations of the basic order type.
All three arithmetic registers are 68 bits. Tag bits enter these registers only on the logical instructions and the shift instruction if it is cyclic or is a Boolean shift. On arithmetic orders, the tag bits are saved in a separate three bit register and the three extra bits in the arithmetic registers are used for checking overflow. Thus the range of numbers in the arithmetic unit is $-128 \leq N < 128$.
Add and subtract are performed the same as for normalized arithmetic, except the result is never shifted left at the end of the operation.
Before multiply is done, the coefficient that has the largest absolute value is normalized. There is no left normalization after the operation. Thus the result has approximately the same number of significant digits as the operand that had the smaller number of significant digits. It does tend to retain an average of about two or more bits than it should, however.
Before divide is done, both operands are normalized but the number of divide steps performed is reduced accordingly so that the result has approximately the same number of significant digits as the operand that had the smaller number of significant digits.

ARITHMETIC UNIT

Operation	Microseconds Excl A T	Incl A T
Fixed point add or subtract	1	5
Fixed or floating multiply	20	25
Fixed or floating divide	60	65
Floating add or subtract	3.0	6
Boolean logic operation	1	5
Indexing and control	2	2(Avg)

Construction (Arithmetic unit only)
The arithmetic unit is constructed of standard vacuum tube logical packages, with tube driven, crystal diode logical gating. The arithmetic unit only is constructed of 1727 vacuum tubes of 4 types, 853 transistors of 3 types, 46,500 diodes of 2 types and 1,600 pulse transformers of 1 type.

Arithmetic mode Parallel
Timing Synchronous

Logical events are controlled by a five-phase clock, permitting decisions at a 5 Mc rate.

Operation Concurrent
Indexing and control will be concurrent with arithmetic operations.
Except for arithmetic or Boolean compare instructions, the test overflow instructions with $P_{33} = 1$, or any arithmetic order that stores in any index register or stores in the location of the next instruction, the machine always gets its next instruction from the memory while it is doing the previous instruction. If this next instruction is one of the control and indexing orders, it is immediately done, unless it is an input-output order or a test overflow order. If it is done, it proceeds to get another instruction and do it, if possible. Thus almost all of the control and indexing orders can be done concurrently with the arithmetic or logical orders. Only the arithmetic and logical orders require the use of the main arithmetic unit of the machine.
All types of input-output orders can be done concurrently with other instructions. Automatic interlocks are provided so as to prevent timing conflict. Reference to a main memory position within the range of either an input or output instruction will halt the computer until the input or output transfer has occurred at that memory position. The computer is released as soon as the transfer of that particular word has been made and does not wait for the entire transfer to be completed. There is no interlock on the index memory when it is used as index registers. Only the effective addresses α, β, γ are conflict checked. The programmer can easily make the computer wait until such a transfer is complete by using the last address in the index range of the inout order in the A, B, or C addresses of a dummy order. An input-output instruction is not started until the previous arithmetic instruction is finished, hence the last arithmetic result may be included in the range of any input-output order.
As many as five input-output orders can be operating concurrently with computing and with each other. There is a separate trunk for reading cards, punching cards, using drum, and two separate trunks for using magnetic tape and all five of these trunks can operate concurrently.

STORAGE

Media	No. of Words	Digits per Word	Access Microsec
Magnetic Core (Main)	4,096	72 binary	2
Magnetic Core (Index)	63	16 binary	1
Magnetic Drums (Two)	24,576		
Magnetic Tapes (Six)			

No. of units that can be connected	16 Units
No. of chars/linear inch	400 Char/in
Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	0.80 Inches
Tape speed	150 Inches/sec
Transfer rate	120,000 Char/sec
Start time	3.0 Millisec
Stop time	3.0 Millisec
Average time for experienced operator to change reel	60 Seconds
Physical properties of tape	
Width	1.0 Inches
Length of reel	2,500 Feet
Composition	0.43 Magnetic coating 1.45 Mil

Provision is made for up to 16,384 words of high speed memory and system can be expanded to 28 tape stations.

INPUT

Media	Speed
Card Reader	800 cards/min
Magnetic Tape	See "Storage"

OUTPUT

Media	Speed
Card Punch	250 cards/min
Magnetic Tape	See "Storage"

Peripheral equipment. A single unit that is capable of converting alphanumerical characters from cards to tape, tape to high speed printer, tape to cards, cards to high speed printer and paper to magnetic tape.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
5847	5,600
6197	110
6C4	110
6AQ5	220
Misc	80
Diodes	
LD70/CTP309	12,600
LD71	100,000
Misc	13,700
Transistors	
2N697	600
2N1143	240
2N398	1,600
Misc	6,300

CHECKING FEATURES

Code checking features will include stopping on any selected address, the display of the contents of any memory cell, the display of normal or abnormal conditions, the ability to manually store in any selected memory cell, and the ability to transfer control to any part of the system. Parity checking is performed in each of the four 17-bit groups in each word.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computing system	35 Kw
Power, air conditioner	20 Kw
Space, computing system	Plenum is 30 ft x 40 ft
Space, air conditioner	Chilled water is sent two flights up to computer site to heat exchanger, transferring heat from computer closed loop air to closed loop chilled water. On ground floor, compressor refrigerant absorbs heat from chilled water. An evaporative system absorbs heat from refrigerant in a cooling tower. Compressor located two floors below. Liquid coolant piped upstairs. Heat exchanger, computer closed-loop air-to-coolant at computer site, and coolant-to-outside air downstairs.
Capacity, air conditioner	25 Tons

PRODUCTION RECORD

Number of systems produced to date 1
Operational date anticipated as 1 April 1961.

COST, PRICE AND RENTAL RATES

The approximate cost, including an additional bank of 4,096 words of high speed memory, 6 tape stations, the system as described, with all peripheral converters and input-output equipment, site preparation, overhead and other related costs will be approximately 2.0 million dollars.

PERSONNEL REQUIREMENTS

	Three 8-Hour Shifts
Supervisors	6
Analysts	3
Programmers and Coders	14
Clerks	1
Engineers	1
Technicians	6

No engineers are assigned to the operation of the machine, but are used for development and design of additions to the machine. The technicians consult the engineers when a total break-down occurs.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

A high degree of reliability is achieved by utilizing standard logical plug-in packages, a ruggedized, long life, driver tube, derated components and point-to-point soldered connections.

INSTALLATIONS

Computing Laboratory
Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland

BURROUGHS 204

Burroughs 204 Electronic Data Processing System

MANUFACTURER

Burroughs Corporation
(Formerly manufactured by the Electrodata Corporation)

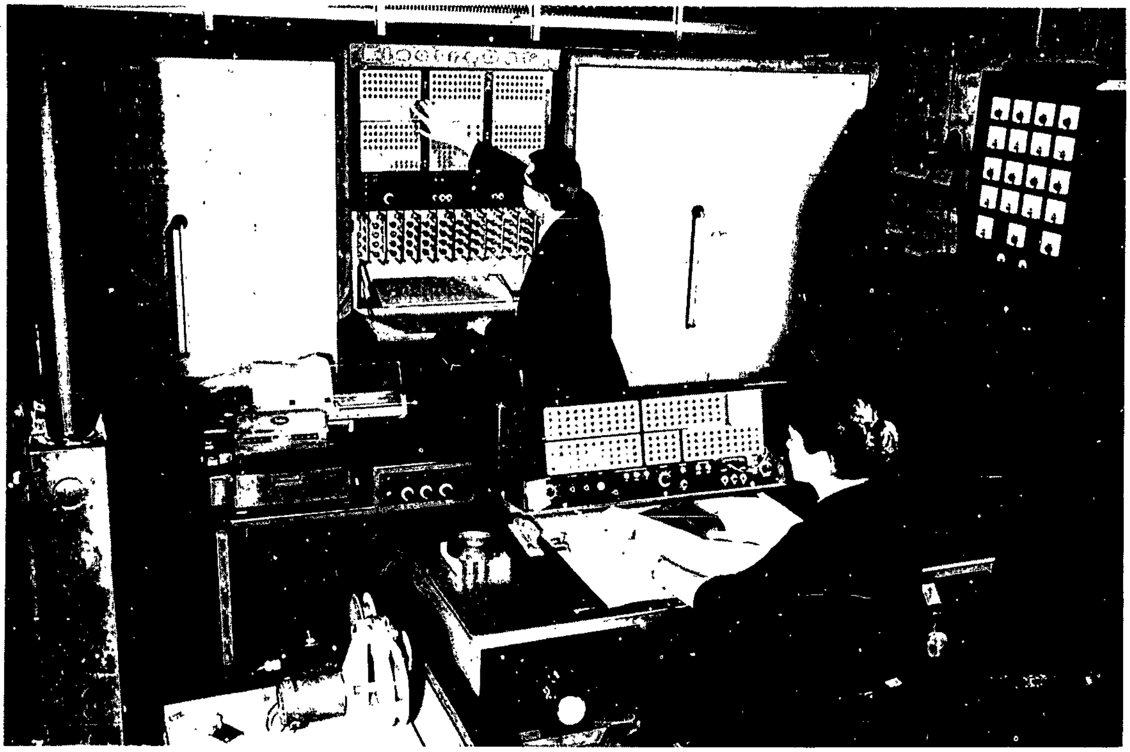


Photo by U. S. Army Ordnance Tank-Automotive Command

APPLICATIONS

Manufacturer
See Burroughs 205 for further details

U. S. Army Tank-Automotive Command
Located at Detroit Arsenal, the system is used for engineering projects (tank firing stability studies, fuel consumption (battlefield day), performance analysis, suspension studies, and data reduction), and for mathematical programs (solution of complex formula and equation, empirical curve fitting, precision simulation of vehicle behavior, land locomotion research support, and mathemetical model development).

U. S. Naval Air Test Center
Located in Armament Test, NATC, Patuxent River, Md., the system is used for reduction of experimental test data concerning naval aircraft and systems. Examples are phototheodolite space positions, aircraft sighting tables, fire control systems test, and aircraft performance - climb, speed, etc.

U. S. Air Force Wright Air Development Center
Located in Bldg. 30, WADD, Wright-Patterson AFB, Ohio, the system is used for scientific data reduction in flight and engineering test field.

American Bosch Arma Corp.
Located at the Arma Division, ABAC, Garden City, N. Y., the system is used for the design, development, testing, and evaluation of inertial guidance systems, airborne digital computers, and other electronic equipment.

California Research Corporation
Located at 527 Standard Avenue, Richmond, California, the system is used for computative work associated with a large petroleum research laboratory. It might be described as calculations resulting from chemical analysis, engineering calculation, and analysis of data.

Convair, Division of General Dynamics Corp.
Located in Building 4, Convair, Pomona (Engineering Computer Laboratories), this machine is used on many varied types of problems, for example, trajectories, evaluation of rational polynomials, finding roots of polynomials, inverse Laplace, heat transfer, optics, regression analysis, scheduling of completion of manufacture of a missile via completion of its parts, etc.

The Dow Chemical Company
Located in A-1201, Room 42, Plant "A", Freeport, Texas, the system is used for the solution of technical and scientific problems.

Great Lakes Pipe Line Company
Located in the Bryant Building, Kansas City, Mo., the system is used to conduct research on product scheduling by computer accounting and administrative control operations.

Photo by American Bosch Arma Corporation

Socony Mobil Field Research Laboratory
Located in Dallas, Texas, the system is used in theoretical studies in fluid flow, elasticity, geophysics, nuclear physics, reservoir engineering, heat transfer, design of experimental apparatus, data reduction and interpretation and engineering design.

Socony Mobil Oil Company, Inc.
Located in Paulsboro, New Jersey, the system is used for problems of large systems of linear algebraic equations, differential equations, statistics, process simulation, and miscellaneous scientific computation.

United Gas Corporation
Located at 8015 St. Vincents Ave., Shreveport, La., the system is used for scientific computing, including mass spectrometer analyses, reservoir mechanics, pipeline flow calculations, instrument design, flash and K-value calculations, and research problems of a non-recurring nature. It is also used for data processing, including special calculations, non-routine in nature, experimentation with data handling and processing procedures, business games, and statistical analysis.

Purdue University Computing Laboratory
Located at ENAD, W. Lafayette, Indiana, the system is used for undergraduate and graduate instruction and research. It is also used for student scheduling.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer
See Burroughs 205 for further details.

ARITHMETIC UNIT

Manufacturer
See Burroughs 205 for further details.

STORAGE

Manufacturer
See Burroughs 205 for further details.

U. S. Army OTAC
Magnetic Drum 4,000 words (Main); Magnetic Drum 80 words (High Speed Loops); Magnetic Tape 800,000 words.

U. S. Naval Air Test Center
Magnetic Drum 4,080 words; Magnetic Tape 400,000 words, 2 units.

USAF WADC
MD 4,080 words; MT 400,000 words/tape.

Arma
MD 4,080; MT 400,000.

Cal Res Corp
MD 4,080

Convair
MD 4,080 words; Magnetic tape can be construed as additional storage. Three tape transports are "on-line" with the system. Each 2500 ft reel of 3/4 inch

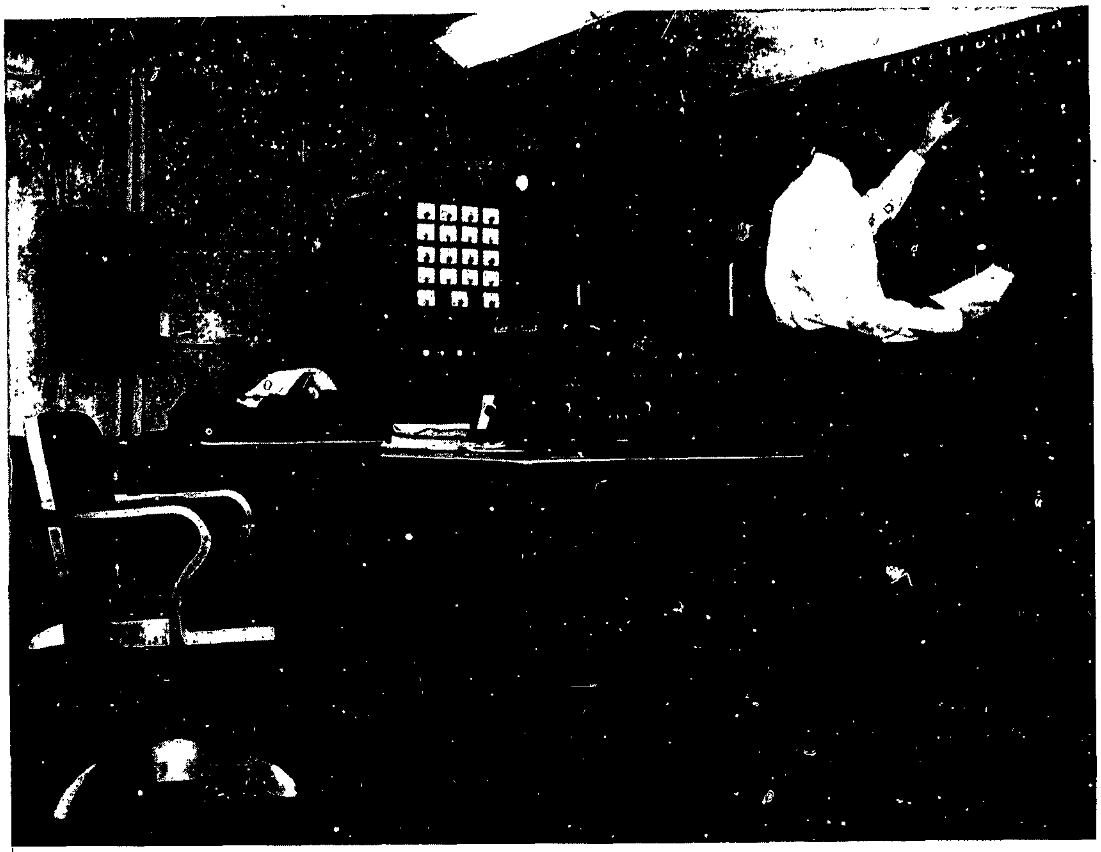


Photo by California Research Corporation

tape can have 10,000 blocks of 20 words-on each of two read/write heads (channels). Approx. 10000X20X2 = 400,000 words.

Dow Chemical

MD 4,080 words; MT 2,000,000 words. The average access time for 80 words of drum memory is 850 microseconds.

Great Lakes Pipe Line

MD 4,080; MT 3 units

Socony - Dallas

MD 4,080; MT 1,200,000 words, 3 units. Tape is addressable. Tape search for a specific location can occur simultaneously with computation. Maximum search time is approximately 7 minutes.

Socony - Paulsboro

MD 4,080 words; MT

United Gas

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum (Main)	4,000	44,000	8,500
Magnetic Drum (Loop)	80	800	850
Magnetic Tape	400,000	4,400,000	240×10^6
DataFile	2,000,000	22,000,000	240×10^4

4 high speed 20-word drum loops (mean random access 850 microseconds). 4,000 word intermediate-speed (3960 rpm) main drum memory. This system has two magnetic tape transports and one Data File.

Purdue

MD 4,080; MT 400,000/reel. If the entire tape is accessed on a random basis, the average access time will be 3.5 minutes.

INPUT

Manufacturer

See Burroughs 205 for further details.

U. S. Army OTAC

Media	Speed
Paper Tape	540 char/sec

Two independent photo electric readers are available for use, each may be called upon for read-in by machine programming.

U. S. Naval Air Test Station

Paper Tape	540 digits/sec
Keyboard	Manual
Magnetic Tape	6,000 digits/sec

USAF WADC

Media	Speed	
IBM Cards	200 cards/min 1,600 - 10 digit words/min	
Auxiliary Tape	400 words/sec	10 digit words
Paper Tape	540 char/sec	optical reader
Keyboard	Manual	
Specialized Inputs		
Low Speed Mag Tape	16 par/sec	on line
High Speed Mag Tape	400 par/sec	off line to Electrodata tape
Dots Converter Tape	70 par/sec	on line

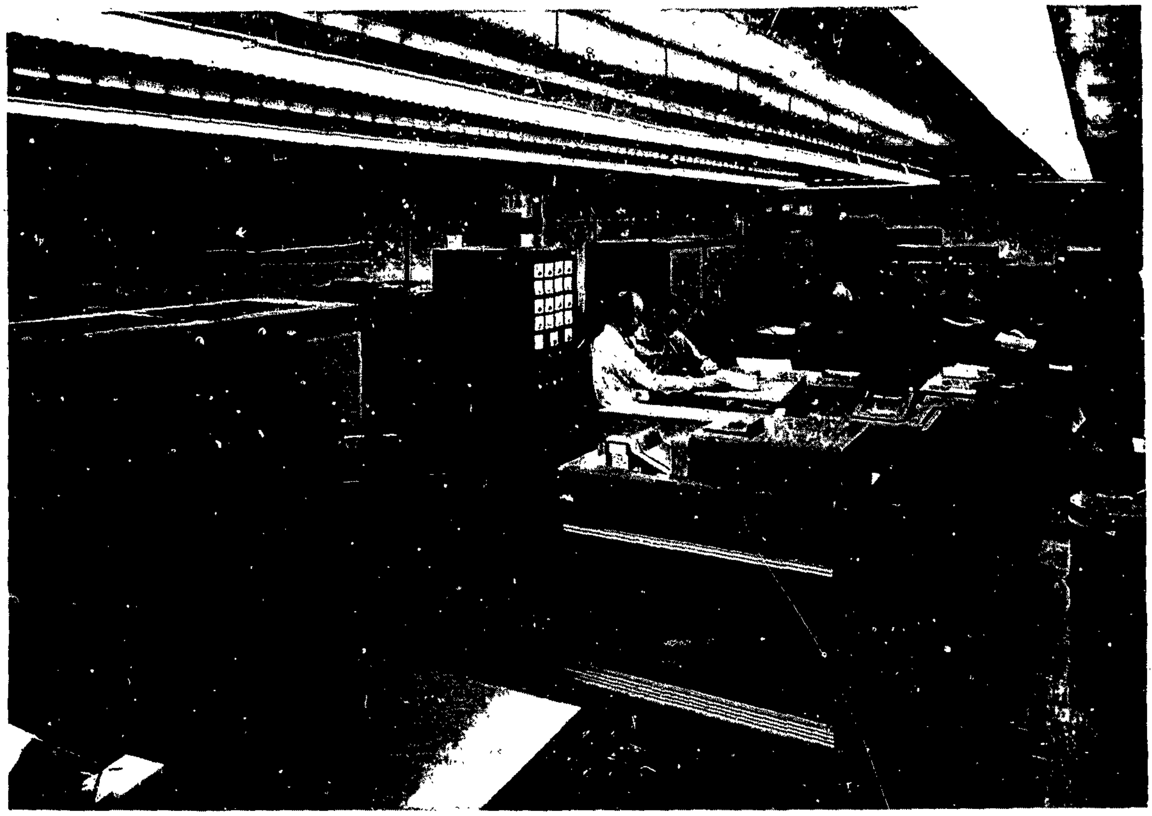


Photo by Convair, Pomona, California

Arma

Media	Speed	
Paper Tape	540 char/sec	Photoelectric reader
IBM Cards	100 cards/min	Via IBM Type 523
Flexowriter	10 char/sec	Commercial Control Equip

Cal Res Corp

IBM Cards	200 cards/min	7 or 8 words/card
Paper Tape	500 char/sec	50 words/sec

Convair

Punched Paper Tape Photoelectric reader	Max 520 char/sec	
IBM Cards	200 cards/min	IBM 528 Card Reader
Keyboard	Manual	

Magnetic tape can be used as input to the computer. (No off-line cards or paper tape to magnetic tape equipment).

Dow Chemical

Punched Cards	100 cards/min
Paper Tape	540 digits/sec
Magnetic Tape	2.5 millisec/word

Great Lakes Pipe Line

Cards (IBM 514)	100 cards/min
Paper Tape (Flexowriter)	20 dig/sec
Paper Tape Manual	600 dig/sec

Socony - Dallas

Paper Tape	540 digits/sec	Photoreader
Magnetic Tape	6,000 digits/sec	
Cards (IBM)	133 digits/sec	Use IBM 514
Keyboard	Manual	

Compatible magnetic tape prepared by off-line A→D converter.

Socony - Paulsboro

Media	Speed	
Punched Cards	200 cards/min	IBM 528
Magnetic Tape	2,300 microsec/word	Searching, reading or writing

United Gas

Paper Tape (mechanical reader)	10 char/sec
Paper Tape (photo reader)	540 dig/sec
Keyboard	Manual
Cards (IBM 528)	266 dig/sec
Magnetic Tape	6,000 dig/sec

Input not buffered.

Purdue

Paper Tape	500 char/sec
Cards 80 column card	200 cards/min

OUTPUT

Manufacturer

See Burroughs 205 for further details.

U. S. Army OTAC

Media	Speed	
High Speed Punch	60 char/sec	
Flexowriter	10 char/sec	
12 D-A Converters		
Digital Plotter		Off line

The off line Flexowriters are available for creating printed copy from high speed paper tape output.

The D-A Converters permit 12 channels of digital information to be presented as analog voltages. The principle use of the D-A Converter is for presenting input data to the analog computer.

Photo by Dow Chemical Company

U. S. N. Air Test Center

Media	Speed	
Typewriter	10 char/sec	
Paper Tape	60 char/sec	
Magnetic Tape	6,000 char/sec	

USAF WADC

IBM Cards	100 cards/min	800 - 10 dig words/min
Tabular	150 lines/min	1,200 - 10 dig words/min
Paper Tape	9 char/min	
Auxiliary Tape		Immediate process

Arma

On Line Printer	150 lines/min	IBM Type 407
Cards (IBM)	100 cards/min	IBM Type 523
Paper Tape	60 char/sec	Burroughs Equip
Flexowriter	10 char/sec	Commercial Controls Equip

Cal Res Corp

Flexowriter	10 char/sec
Paper Tape	60 char/sec
IBM Cards	100 cards/min
IBM 407 Printer	150 lines/min

7 or 8 words per card.

Convair

Paper Tape	60 char/sec	Teletype Punch
Cards	100 cards/min	IBM 528 Card Punch
Printer	150 lines/min	IBM 407 Line Printer
Flexowriter	10 char/sec	

Magnetic tape can be used as output from the computer. (No off-line cards or paper tape to magnetic tape equipment.)

Dow Chemical

Cards	100 cards/min
Printer	100 lines/min
Paper Tape Punch	60 digits/sec

Great Lakes Pipe Line

Cards (IBM 514)	100 cards/min
Flexowriter (typewriter)	20 digits/sec
Paper Tape (Flexowriter)	20 digits/sec

Socony - Dallas

Printed Page	200 dig/sec	Use on line IBM 407
Printed Page	10 dig/sec	On or off line Flexowriter
Paper Tape	10 dig/sec	Friden tape punch
Cards	133 dig/sec	Use IBM 514
Continuous Curve Plot	33-166 points/sec	Use D → A converter and high speed recorder
F.M. Analog Tape	250 samples/sec	Use D → A converter and computer controlled F.M. tape recorder

Socony - Paulsboro

Punched Cards	100 cards/min	IBM 528

United Gas

Typewriter	10 dig/sec
Paper Tape	20 dig/sec
Magnetic Tape	6,000 dig/sec
Cards (IBM 528)	135 dig/sec
Printer (IBM 407)	200 dig/sec

Output not buffered.

Purdue

Paper Tape	60 char/sec
Cards	100 cards/min 80 col. card
Typewriter (Flexowriter)	10 numeric char/sec 5 alpha char/sec

Photo by United Gas Corporation

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer
See Burroughs 205 for further details.

CHECKING FEATURES

Manufacturer
See Burroughs 205 for further details.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer
See Burroughs 205 for further details.

U. S. Army OTAC

Power, computer	19.2 Kw	21.2 KVA	0.9 pf
Power, air cond	15.4 Kw	20.5 KVA	0.75 pf
Volume, computer		388 cu ft	
Volume, air conditioner		188 cu ft	
Area, computer		133 sq ft	
Area, air conditioner		25 sq ft	
Room size, computer		30 ft x 22 ft	
Room size, air conditioner		4 ft x 15 ft	
Floor loading		50 lbs/sq ft	
Capacity, air conditioner		25 Tons	
Weight, computer		7,295 lbs	
Weight, air conditioner		2,596 lbs	

Air conditioner: One 10-ton unit and one 15-ton unit. Raised floor to facilitate routing of electrical connectors. Installation of power distribution boxes, etc. Temperature and humidity control (air conditioning). Lighting and acoustic ceiling.

U. S. N. Air Test Center

Power, computer	26.5 KVA
Power, air conditioner	9.7 Kw
Volume, computer	427 cu ft
Volume, air conditioner	142 cu ft
Area, computer	79 sq ft
Area, air conditioner	18 sq ft
Room size, computer	19 ft x 23 ft
Floor loading	130 lbs/sq ft
Capacity, air conditioner	10 Tons
Weight, computer	7,130 lbs
Weight, air conditioner	2,400 lbs

Computer housed on second floor with wiring ducted under floor (no ceiling under second floor). Motor generator installed outside of building. Air conditioner housed in off-set from computer room.

USAF WADC

Power, computer	20.39 Kw	22.66 KVA	0.9 pf
Power, air cond	13.19 Kw	12.65 KVA	0.9 pf
Volume, computer		615.32 cu ft	
Volume, air conditioner		436 cu ft	
Area, computer		124.43 sq ft	
Area, air conditioner		72 sq ft	
Room size, computer		18 x 30 x 14 ft	
Room size, air conditioner		15 x 15 x 15 ft	
Floor loading		102 lbs/sq ft	
Capacity, air conditioner		15 Tons	
Weight, computer		8,534 lbs	
Weight, air conditioner		4,000 lbs	

Insulation, sound-proofing, platform floor, boarded up outside windows, power in conduit under flooring. Temperature and humidity control.

Arma

Power, computer	35 KVA	0.8 pf
Power, air conditioner	29.8 Kw	
Volume, computer	11,106 cu ft	
Area, computer	473 sq ft	
Room size, computer	36 ft x 37 ft	
Floor loading	130 lbs concen max sq ft	
Capacity, air conditioner	40 Tons	
Weight, computer	17,650 lbs	

3/16 inch masonite base covered with Kentile flooring; false ceilings; wall partitions, fluorescent lighting, channels in floor for electrical connectors and cabling, steel superstructure for mounting air conditioning unit.

Cal Res Corp

Power, computer	20 KVA
Volume, computer	530 cu ft
Area, computer	102 sq ft
Room size, computer	20 ft x 35 ft
Floor loading	130 lbs/sq ft
	8,815 lbs concen max
Weight, computer	10,405 lbs

False floor 4 feet above regular floor to provide plenum chamber, cable ways, and at the same time to make floor level with adjacent offices. Entrance and exhaust air ducts installed. Motor generator set installed in basement. Building air conditioning system used.

Convair

Power, computer	37.5 KVA
Power, IBM 407 & 528	3.7 KVA
Power, air conditioner	19.8 KVA
Volume, computer	410.5 cu ft
Volume, IBM 407 & 528	100.0 cu ft
Volume, air conditioner	378.0 cu ft
Area, computer	78.5 sq ft
Area, IBM 407 & 528	25.0 sq ft
Area, air conditioner	54 sq ft
Eoom size, computer	800 sq ft
Floor loading	200 lbs/sq ft
	250 lbs/sq ft concen max
Capacity, air conditioner	14 Tons
Weight, computer	7,867 lbs (Exclud IBM Equip)
Weight, IBM 407 & 528	4,716 lbs
Weight, air conditioner	2,400 lbs

Trenches were cut in floor (concrete) for cables. Steel plates cover trenches. 2-10 ton air conditioning units to supplement main system were installed and ducting rerouted.

Dow Chemical

Power, computer	20 Kw	20 KVA	1.0 pf
Power, air cond	13.5 Kw	15 KVA	0.9 pf
Volume, computer		675 cu ft	
Volume, air conditioner		105 cu ft	
Area, computer		134 sq ft	
Area, air conditioner		15 sq ft	
Floor loading		20 lbs/sq ft	
		215 lbs concen max	
Capacity, air conditioner		15 Tons	
Weight, computer		13,000 lbs	
Weight, air conditioner		1,500 lbs	

Attic painted with fire resistant paint.

Socony - Dallas

Power, computer	35.0 KVA
Volume, computer	181 cu ft
Area, computer	37 sq ft
Room size, computer	870 sq ft
Floor loading	14.9 lbs/sq ft
	704 lbs concen max
Weight, computer	13,000 lbs

Computer room is 29 ft x 30 ft with acoustical treatment of ceiling and walls. Interconnecting cables suspended in trays beneath rubber tile covered concrete floor. Room has temperature and humidity controls. Power distribution made in accordance with manufacturer's recommendations. Air conditioner is main building system with special controls.

Socony - Paulsboro

Power, computer	46 KVA	0.90 pf
Power, air conditioner	10 KVA	0.85 pf
Volume, computer	540 cu ft	
Volume, air conditioner	105 cu ft	
Area, computer	95 sq ft	
Area, air conditioner	14 sq ft	
Room size, computer	24 ft x 20 ft	
Room size, air conditioner	5 ft x 12 ft	
Floor loading	90 lbs/sq ft	
	130 lbs concen max	
Capacity, air conditioner	10 Tons	
Weight, computer	8,700 lbs	
Weight, air conditioner	3,000 lbs	

No special site preparations.

United Gas

Power, computer	29 KVA
Volume, computer	181 cu ft
Volume, air conditioner	105 cu ft
Area, computer	28 sq ft
Area, air conditioner	15 sq ft
Room size, computer	24 x 31 ft
Room size, air conditioner	Not housed separately
Capacity, air conditioner	22 Tons
Weight, computer	4,000 lbs
Weight, air conditioner	2,800 lbs

Cable raceways were installed. Air conditioner is a ArkLa Servel DUT water chiller. Energy source - low pressure steam at 464 lbs/hr. Heat input 450K BTU per hour.

Purdue

Power, computer	22 Kw	23 KVA	0.957 pf
Power, air condit	10 Kw	11 KVA	0.91 pf
Volume, computer		560 cu ft	
Volume, air conditioner		72 cu ft	
Area, computer		80 sq ft	
Area, air conditioner		12 sq ft	
Room size, computer & A/C		760 sq ft	
Floor loading		600 lbs/sq ft	
Capacity, air conditioner		10 Tons	
Weight, computer		6,000 lbs	
Weight, air conditioner		1,000 lbs	

A trench was cut in the concrete floor for the connecting cables. All air conditioner ducting and power conduit was run exposed. Storm windows were installed.

PRODUCTION RECORD

Manufacturer

See Burroughs 205 for further details.

COST, PRICE AND RENTAL RATES

U. S. Army OTAC

The Burroughs 204 Computer, console, high-speed punch, photo electric reader, and Flexowriter cost $150,000.

The magnetic tape control and storage units cost $50,000; the floating point unit cost $21,000; the data plotter cost $9,000; and the tape perforator and verifier cost $4,000.

Maintenance (contractual and inhouse) cost $55,000 per year.

U. S. N. Air Test Center

1	204	Burroughs
1	402	Console
2	446	Typewriter Console
3	458	Modified Flexowriters
1	543	Tape Control
2	544	Data Readers
1	360	Floating Point Control
1	466	High Speed Tape Punch

Total cost is $227,000.
Maintenance cost is $17,800/year.

USAF WADC

Central computer, console, Flexowriter, and phototape reader cost $139,582.
The card converter and magnetic tape cost $74,670.
The IBM 407 and 528 rents at $12,466/year.
The IBM 519, 024, 523, and 031 rent at $5,292/yr.

Arma

The basic computer and power control unit cost $119,200.

8 Tape Units	Computer Console
1 Datafile	Code Converter
Floating Point	3 Flexowriters
Tape and Control Unit	2 Tape Preparation Units
Punch Card Converter	

Total cost of additional equipment is $232,000.
2 IBM Type 523 rent at $187/month, and 1 IBM Type 407 rents at $880/month.
$42,000/yr. full two shift coverage maintenance contract.

Cal Res Corp

The 204 Computer, card converter, console, typewriter, floating point unit cost $178,000.
Paper tape reader and punch cost $8,000.
On Burroughs equipment, the maintenance cost $1,010/month.

Convair

Basic System

Digital Computer No. 204	$119,200
Control Console No. 409	11,231
Typewriter Control Unit No. 446	4,560
Flexowriter No. 458	3,135
Keyboard and Reader No. 454	1,500
Total Cost	$139,626

Auxiliary & Additional Equipment

Magnetic Tape Control No. 543	$18,560
2 Magnetic Tape Storage No. 544	29,350
Miscellaneous additional equipment	20,740
Spares Kits	6,453
Digital to Analog Converter	4,950
Flexowriter	3,135
Plotting Board 11" x 17"	1,925
Floating Point Control Unit w/spares	19,528
Paper Tape Reader	600
Photo Reader Assembly	4,180
Total Cost	$109,421

Basic System

2	IBM No. 026 Printing Card Punch at $69.15	$138.30
1	IBM No. 063 Card to Tape Punch	99.00
1	IBM No. 082 Sorter	60.50
1	IBM No. 407 Alphabetic Accounting Machine	912.50
1	IBM No. 519 Document Originating Machine	295.00
1	IBM No. 528 Accumulating Reproducer	258.60
1	Burroughs/EDC No. 500 Card Converter	481.95
1	Burroughs/EDC No. 544 Magnetic Tape Storage	318.75
	Total Monthly Rental	$2,564.60

Additional Equipment

2	IBM No. 066/068 Card Transceiver	
	Total Monthly Rental	$429.00

Dow Chemical

The total basic system cost $242,775 and the rental is $7,702/month.
Do own maintenance and servicing.

Socony - Dallas

Model 204 Computer with power control, control console, photoreader, paper tape punch, Flexowriter, format control, magnetic tape control, 1 tape transport, keyboard cost $169,000.
Model 500 Punched Card Converter, floating point control, 2 tape transports, external switch and output selector purchased for approximately $68,200.
IBM 407 rental approximately $900/month. IBM 514 rental approximately $125/month.
Maintenance and modification performed by Secony Mobil.

Socony - Paulsboro

Burroughs 204, Model 500 Punched Card Converter cost $156,000.
Model 543 Tape Control, Model 544 Datareader, Model 360 Floating Point Control cost $58,000.
Model 544 Datareader rents for $4,500/year.
Maintenance, including parts, is $21,000/year.

United Gas

204 Computer	500 Punch Card Converter
406 Console	543 Tape Control
446 Typewriter Console	360 Fl. Point Control
458 Flexowriter	2-544 Datareaders
420 External Switch	1-560 DataFile

Total cost is $275,105.
The IBM 407, IBM 519, IBM 077, IBM 026, IBM 010, IBM 528, IBM 083, IBM 548, and IBM 056 rent at $2,000/month.

Purdue

The computer, console, typewriter control unit cost $139,000.
The 500 Card Converter, two tape transports and tape control unit cost $70,000.
Maintenance cost $17,000/year.

PERSONNEL REQUIREMENTS

Manufacturer

See Burroughs 205 for further details.

U. S. Army OTAC

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	5	5
Coders	-	1
Technicians	1	1

One additional technician is used for the second and third 8-hour shift. Production problem runs are performed during the second shift utilizing maintenance technicians whenever possible as input-output operators. The third shift is used for machine maintenance only.
Operation tends toward closed shop.
Methods of training used include on-the-job training and facility training courses in machine coding and programming.

U. S. N. Air Test Center

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	1	2
Programmers	8	8
Coders	3	3

The primary duty of those listed as programmers is the reduction of data from film and oscillograph records. These personnel are rated as mathematicians or mathematics aids. The programming they do is to a

large extent directly related to their assigned data reduction tasks. The training they receive in programming is that which is available from the computer manufacturer.

Operation tends toward open shop.

USAF WADC

	One 8-Hour Shift
Supervisors	1
Analysts, Programmers & Coders	6
Operators	1
Engineers	2
Technicians	2
In-Output Operators	1

Work 2nd shift approximately 1/4 of year. Split up personnel for this. Mostly production type work.

Operation tends toward closed shop.

Formal training provided by Burroughs and IBM and "on-the-job" experience.

Arma

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	1	2
Analysts, Program & Coders	12	14
Operators	2	2
In-Output Operators	1	2

Operation of this system is supplemented by an average of 30 hors/month IBM Type 704/709 time. Portion of personnel whose effort applies directly to this system varies from time to time. Above figures represent total personnel for all digital computer programming and operation.

Operation tends toward closed shop.

Methods of training used is in-plant training by senior personnel.

Cal Res Corp

	One 8-Hour Shift
Supervisors	1
Analysts, Programmers	3
Coders	3
Clerks	1
Operators	2

Above figures are about right for mature organization.

Operation tends toward closed shop.

Methods of training used are vendor training programs and on-the-job training.

Convair

	One 8-Hour Shift	Two 8-Hour Shift
Supervisors	1	
Analysts	8	
Programmers	8	
Coders	2	
Clerks	1	
Operators	1	1
Engineers	1	1
Technicians	1	1
In-Output Operators	1	1

Operation tends toward closed shop.

Methods of training used are self study and work experience with senior personnel.

Dow Chemical

	One 8-Hour Shift
Supervisors	1
Analysts	1
Clerks	1
Engineers	1

Operation tends toward open shop.

Methods of training used is on-the-job training.

Great Lakes Pipe Line

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	2
Operators	1

Operation tends toward open shop.

Methods of training used are manufacturer's training and internal on-the-job training.

Socony - Dallas

	One 8-Hour Shift
Supervisors	2
Analysts	7
Programmers	3
Technicians	5

The above entries must be taken with a grain of salt for two reasons:

We have never been organized under the usual class system. Supervisors are analysts, analysts program and operate the computer, operators program, and programmers operate.

With the above personnel we also use about 10 hours a week of 704 time in the Socony New York Computing Center.

Operation tends toward closed shop.

Methods of training used includes maintenance courses offered by manufacturer, programming courses offered within the group, and on-the-job training.

Socony - Paulsboro

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts, Prog. & Coders	Variable	
Clerks	3	3 or more
Operators	1	1
Technicians	1	1

Operation tends toward closed shop.

Methods of training used are on-the-job training, no formal classes.

United Gas

	One 9-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts & Programmers	2	4
Operators	3	3
Engineers	2	2

Operation tends toward open shop.

Methods of training used are on-the-job and informal classroom.

Purdue

	Three 8-Hour Shifts
Supervisors	1
Analysts, Programmers & Coders	7
Clerks	1
Operators	5
Engineers	1
Technicians	2

Operation tends toward open shop.

Methods of training used are lectures and labs.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

See Burroughs 205 for further details.

U. S. Army OTAC

Good time	90 Hours/Week (Average)
Attempted to run time	100 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.90

Above figures based on period 1 Jan 59 to 31 Dec 59

Passed Customer Acceptance Test Jul 56

Time is not available for rent to outside organizations.

U. S. N. Air Test Center
Figures based on period 1 Feb 56 to 31 Mar 60
Passed Customer Acceptance Test Jan 56
Operating experience is kept on a monthly basis.
The figures below are monthly averages:

Production	91.5 Hours
Program Check	44.1 Hours
Idle	15.7 Hours
Down	18.4 Hours
Demonstration	0.4 Hours

Time is available for rent to outside organizations.

USAF WADC
Good time 43.10 Hours/Week (Average)
Attempted to run time 45.34 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.951
Above figures based on period 1 Jan 58 to 1 Jan 60
Passed Customer Acceptance Test Jan 56
Time is not available for rent to outside organizations.

Arma
Good time 76 Hours/Week (Average)
Attempted to run time 80 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period from Aug 59 to Aug 60
Passed Customer Acceptance Test Mar 57
Time is not available for rent to outside organizations.
2 shift operation.

Cal Res Corp
Average error-free running period 8 Days
Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.96
Above figures based on period from 56 to 60
Passed Customer Acceptance Test 16 Jul 56
Time is available for rent to qualified outside organizations.

Convair
Good time 81 Hours/Week (Average)
Attempted to run time 85 Hours/Week (Average)
Operating ratio 0.953
Above figures are based on period from Jan 59 to Jan 60
Passed Customer Acceptance Test Jan 56
Time is available for rent to qualified outside organizations.

Dow Chemical
Good time 33 Hours/Week (Average)
Attempted to run time 35 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period from Feb 60 to Aug 60
Passed Customer Acceptance Test Feb 60
Time is not available for rent to outside organizations.

Great Lakes Pipe Line
Operating ratio 0.90
Above figure based on period from Jan 59 to Jun 60
Passed Customer Acceptance Test Oct 56
Time is not available for rent to outside organizations.

Socony - Dallas
Figures based on period from 15 Mar 55 to 31 Mar 60
System is operated on basis of all up or all down including input/output devices. System has been moved and has had extensive field modification. Entire system is checked out each day prior to use.
Records for system time are kept as follows:

Test routines (for system checkout)	601 Hours
Scheduled maintenance	1,882 Hours
Unscheduled maintenance	781 Hours
System modifications	1,158 Hours
Good operation	12,274 Hours

Time is not available for rent to outside organizations.

Socony - Paulsboro
Average error-free running period 2 Hours
Good time 30 Hours/Week (Average)
Attempted to run time 34 Hours/Week (Average)
Operating ratio 0.882
Above figures based on period from Jan 59 to Jan 60
Passed Customer Acceptance Test Dec 54
Time is not available for rent to outside organizations.

United Gas
Good time 47 Hours/Week (Average)
Attempted to run time 52 Hours/Week (Average)
Operating ratio 0.904
Above figures based on period 1 Jan 56 to 1 Aug 60
Passed Customer Acceptance Test Dec 55
Time is not available for rent to outside organizations.

Purdue
Average error-free running period 15 Hours
Good time 130 Hours/Week (Average)
Attempted to run time 140 Hours/Week (Average)
Operating ratio 0.93
Above figures based on period from Jun 59 to Apr 6C
Passed Customer Acceptance Test Jan 55
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
See Burroughs 205 for further details.

U. S. Army OTAC
Outstanding features are ability to use the digital computer for data input to the analog computer and digital plotting board for direct off-line plotting of problem variables as required.
Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include:
Programmers collectively maintain the necessary tape files. Special precautions are not exercised or required to protect tape files.

U. S. N. Air Test Center
Outstanding feature is the index register, decimal number system, capability of expansion of features, and floating and fixed point arithmetic.
Tape is used largely for storing programs and intermediate results of computation. Small quantities of tape are required. Tapes which will in the near future be prepared from automatic data gathering systems will be property of other groups and storage of tape reels will not be required.

USAF WADC
System is used for conversion of specialized tape inputs, for editing volume data and for computation as required by presentation form; conversion, editing and computation in one system.
Magnetic tapes are stored under temperature and humidity control, and are labeled and stored in a steel cabinet.

Arma
Magnetic tapes are identified by "stick-on" labels, stored in plastic containers, which in turn are stored in metal tape cabinets.

Convair
Outstanding features are alphabetic input via punched card converter; time clock (prints run time on paper tape); B + n modification (permits increasing index register by any number); and B1 $\rightarrow$ 4 and change control (makes the 4000 loop in memory as usable as the 7000 loops). A second paper tape reader

has been installed to monitor computer operation during unattended operation.

Tape handling:

Plastic cases for each reel of tape are used. The reels are then stored in a steel cabinet. The cabinet is in the computer room which is temperature and humidity controlled.

Socony - Dallas

Outstanding features are versatile input-output systems, an extensive command structure, on line curve output, F.M. analog magnetic tape output, and added commands.

United Gas

Unique system advantages are addressable magnetic tape blocks; modified logic to allow incrementing and decrementing of index register by integers in the range: 001 $\leq$ integer $\leq$ 1000; modified photo-reader logic to allow input from special magnetic tape reader; and modified Model 500 Punched Card Converter to permit 120 alphanumeric characters per line on IBM 407.

FUTURE PLANS

U. S. Army OTAC

Installation of necessary equipment to permit rapid reduction of analog tests data collected in the field and laboratories.

U. S. N. Air Test Center

Need increased printing speed; medium, but not high speed.

USAF WADC

Digital Computation Branch, now in control of this facility, will acquire an IBM 7090 Computer System and shift the computing now done on the Burroughs 204 to the new 7090 System. The 204 will then be surplused or used as a data converter, editor, and data handling facility.

Arma

No changes in this system are presently contemplated. Arma will continue to use this system, supplemented as required by additional time on the IBM Types 704, 709, 7090 Computers, purchased from subcontractors' facilities. At such time when the total cost of all digital computer operations becomes large enough to economically justify the acquisition of a large computer, Arma will acquire such a computer, and return the Burroughs system to the U. S. Air Force.

Convair

Anticipated modifications:

Provide capability for 8 level binary input/output.

New systems:

Data transmission to and from San Diego over leased telephone lines. Present IBM units will eventually be replaced by units capable of higher capacity (speed).

Socony - Paulsboro

Present plans are to dispose of the computer and transfer the present work load to a larger computer within the company, using an IBM transceiver with a 24-hour telephone line.

Purdue

The Sperry Rand Corporation will install a Univac Solid State 80 Computer with magnetic tape adjacent to our existing facility.

INSTALLATIONS

U. S. Army Ordnance Tank-Automotive Command
R & E Directorate, Research Division
Detroit Arsenal
Detroit 9, Michigan

U. S. Naval Air Test Center
Armament Test
Patuxent River, Maryland

U. S. A. F. Wright Air Development Center
Air Research and Development Command
Digital Computation Branch (WWDCD)
Wright-Patterson Air Force Base, Ohio

American Bosch Arma Corporation
Arma Division
Garden City, New York

California Research Corporation
527 Standard Avenue
Richmond, California

Convair
Division of General Dynamics Corporation
P. O. Box 1011
Pomona, California

The Dow Chemical Company
Texas Division, Plant A
Freeport, Texas

Great Lakes Pipe Line Company
P. O. Box 2239
Kansas City, Missouri

Socony Mobil Field Research Laboratory
Applied Mathematics Section
P. O. Box 900
Dallas 21, Texas

Socony Mobil Oil Company, Inc.
Research Department
Paulsboro Laboratory
Paulsboro, New Jersey

United Gas Corporation
Research Laboratory
P. O. Box 1407
8015 St. Vincents Avenue
Shreveport, Louisiana

Purdue University
Computing Laboratory
ENAD
W. Lafayette, Indiana

BURROUGHS 205

Burroughs Model 205 Electronic Data Processing System

MANUFACTURER

Burroughs Corporation

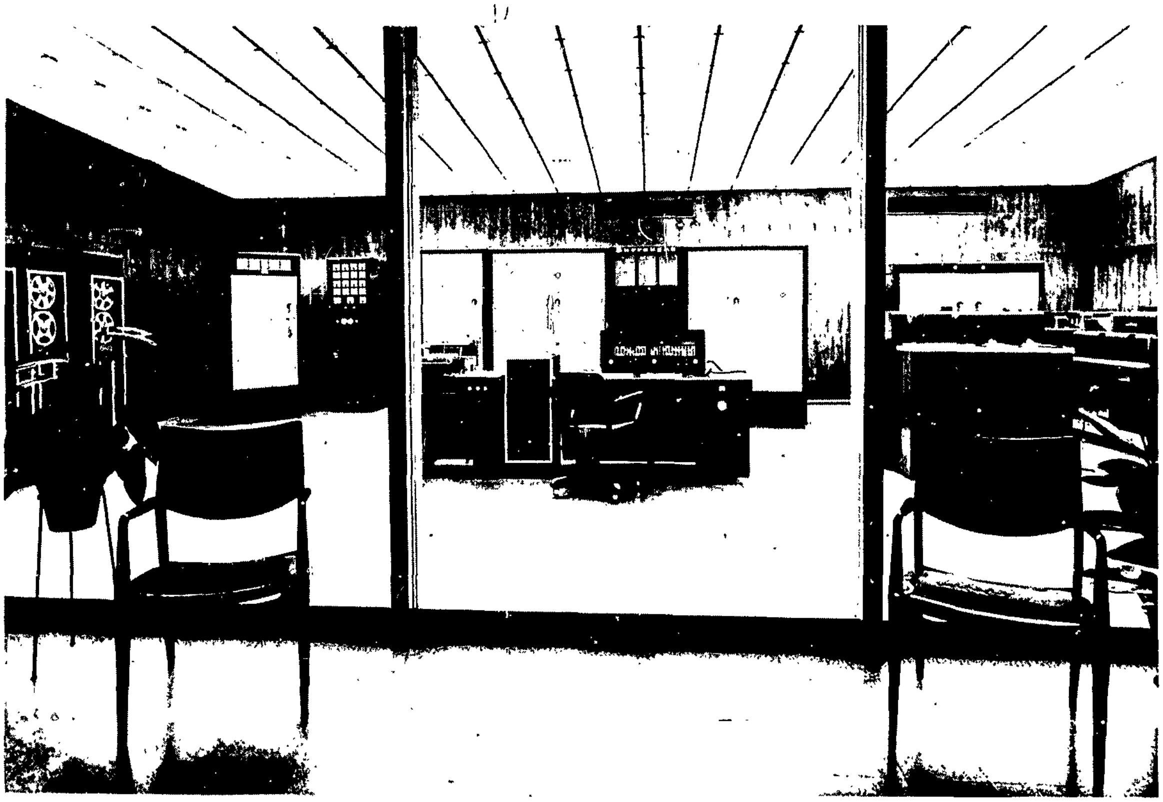


Photo by Burroughs Corporation

APPLICATIONS

Manufacturer
System is designed specifically to cope with the full range of electronic computing problems in the fields of business industry, science and government.

U. S. Army Ballistic Missile Agency
Five systems used for missile research and development.

Army Rocket and Guided Missile Agency
Located at the Test & Evaluation Lab, OML Division, Bldg. 7437, the system is used for data reduction and theoretical investigations.

U. S. Army Chemical Center
Mathematical research - chemical warfare (scientific)

U. S. Naval Shipyard, Boston
Hull deflection (elastic curve afloat), design division project control, hull deflection (in dry dock), plan status report, design division workload (conversions), head loss in fluid piping, prediction of compartment noise levels, gantt charting drawing schedules, vendors drawings and manuals status report, critical speed of rotors, voltage drop in circuits, vent duct sizing, shock mount calculations, tank capacity tables, shafting bearing reactions, pipe stress, design drawing control and scheduling, pipe system sizing, bearing wear down calculation, inventory, work load and payroll.

U. S. Navy Hydrographic Office
Located FOB No. 3, Room 1770, Computation Division, system is used for oceanographic computations for sea water density, sound velocity, specific volume and dynamic dept anomalies, stability and heat index, ice prediction and power spectrum analysis, bathythermograph analysis such as thermocline characteristics, average structure and classification, and navigational computations for such systems as Loran, Lorac, Rafos, Consolan, etc.

U. S. Navy Mine Defense Laboratory
Located at the U.S. Navy Mine Defense Laboratory, Panama City, Florida, system is used for scientific and engineering problems arising from research and development work in naval mine and torpedo warfare; statistical routines; warfare games; acoustic transmission; magnetic field computations; evaluation of navigation systems, etc. Some time is devoted to Laboratory accounting problems.

U. S. Naval Ordnance Laboratory
Located at the U.S. Naval Ordnance Laboratory, Corona, California, system is used for analysis of production and quality control of Navy missiles and missile systems, and for research, development, test and evaluation of Navy missiles and missile systems.

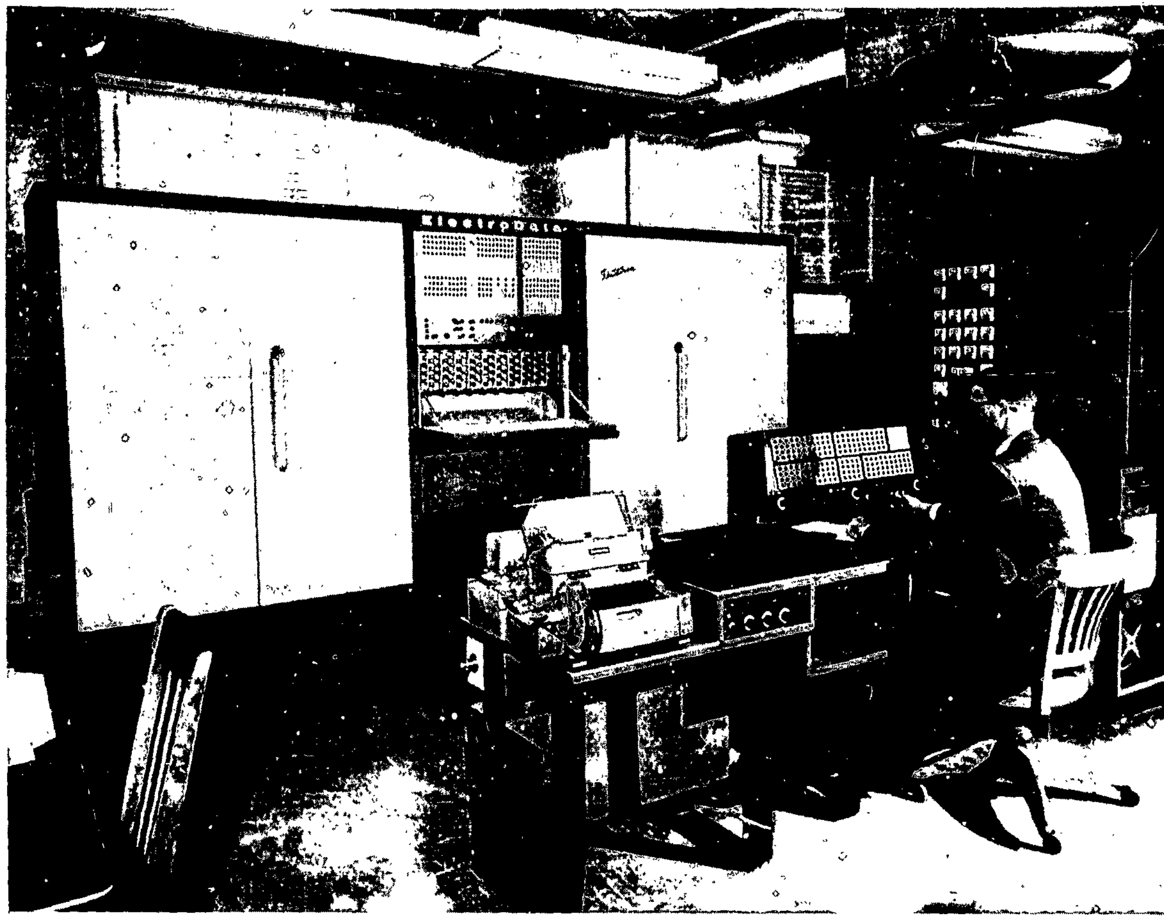


Photo by U. S. Army Chemical Center

U. S. Naval Radiological Defense Laboratory
System is used for scientific problems pertaining to fallout distribution, gamma ray penetration, ship shielding, etc.

U. S. Navy Underwater Sound Laboratory
Applications are scientific and engineering calculations and scientific data processing.

Griffiss AFB, N. Y.
Located at Griffiss AFB, N.Y. (Rome Air Development Center), system is used for statistical reporting and scientific problem solution.

Ames Research Center, NASA
Located at the Ames Research Center, NASA, Moffett Field, California, system is used for on-line wind-tunnel data reduction, off-line data reduction (wind-tunnel, flight, etc.) and scientific calculations (differential equations).

Allstate Insurance Co., Menlo Park, Sacramento, and Atlanta
Used for policy issuance and accounting relative to the policyholder. Policies are stored at random in the datafiles for policy issuance and accounting. Used also for consolidation of accounting and statistical work.

Aerospace Technical Intelligence Center
Located in Bldg. 828, Area A, WPAFB, Ohio, system is used for performance calculations for aircraft and guided missiles.

Arthur D. Little, Inc.
Located at 35 Acorn Park, Cambridge, Massachusetts, system is used for payroll, labor cost distribution, billing, budget analysis reports, statistical survey analysis, inventory and production control simulations, pipe stress analysis, linear and dynamic programming development, ballistic missile trajectories, and multiple regression analysis techniques.

Atlantic Mutual Insurance Company
Located at 80 Pine Street, New York City, system is used for account checking, cargo billing, premium statistics, payroll cost allocation, budget experience, loss statistics, loss reserves, loss processing, premium billing, account analysis, premium reserve calculations, preparation of rating manual on non-bureau auto policy, and calculation on premium earned by state.

Babcock & Wilcox Research Center, Alliance
Used for experimental data reductions, product design, preliminary project analysis, and statistical evaluation of data.

Babcock & Wilcox Co., Lynchburg
System is located at 1201 Kemper Street, Lynchburg, Va. and is used for nuclear studies, (one dimension, criticality and lifetime calculations); thermal and fluid dynamics, (one and two dimensional heat dif-

Photo by the Boston Naval Shipyard

fusion, transient and steady state analysis of steam generator, heat exchanger, etc); data reduction, (experimental data corrected, normalized and correlated); kinetics, (integration of systems of differential equations) and miscellaneous, (shielding, structural, chemical, economic, statistical calculations).

Burroughs Corporation, Computer Facility
Located at 460 Sierra Madre Villa, Pasadena, California, the system is used for debugging of programs for manufacturer's customers, corporate data processing, and block time rentals to the public.

Celanese Chemical Company
Located at 520 Lawrence Street, Corpus Christi, Texas, the system is used for chemical process analysis, equipment design, sales analysis, inventory control, freight analysis, and accounting.

Citizen Gas and Coke Utility
Located at 2020 N. Meridan Street, Indianapolis, Indiana, the system is used for customer accounting operation, including billing, maintenance of accounts receivable, handling of cash, and all other items necessary in maintenance of customers accounts (160,000 accounts, payroll and materials control.

General Electric, Rome
Located in Rome, Georgia, the system is used for engineering design, drafting design, salary payroll, hourly payroll, general accounting reports, cost accounting reports, employee benefits, issuance of manufacturing paper, inventory control, and work station loading.

General Insurance Company of America
Located in Seattle, Washington, at 4347 Brooklyn, the system is used for rerating of automobile insurance policies, preparation of agents commission statements, preparation of sales and underwriting statistics, preparation of expense distributions, allied accounting reports, and analysis of claims experience.

International Telephone and Telegraph Laboratories
Located at 492 River Road, Nutley, New Jersey, the system is used for scientific studies such as missile trajectories, dynamic stability, miss distance, waveguide analysis, radar error analysis, quality control, vibration studies, communication networks, rocket design, etc.

Kaiser Steel Corporation
Located in Fontana, California, the system is used for accounting (departmental cost statements), stores (stock status, reorder notices), statistical analysis (various), and miscellaneous engineering and research studies.

Linde Company
Located at Tonawanda, New York, system is used for

Photo by the U. S. Naval Ordnance Laboratory, Corona

technical and scientific applications including thermodynamic properties and analysis, cryogenic engineering process and equipment design, structural design, processing of experimental data, and operations research.

Louis Allis Company

Located at 427 East Stewart Street, system is used for engineering designs of electrical motors and motor components, payroll, accounts receivable and payable, cost accounting, production control, and other commercial applications. 25% usage is engineering and 75% usage is commercial.

Minnesota Mutual Life Insurance Company

Located at 345 Cedar Street, St. Paul 1, Minnesota, the system is used for premium billing and accounting, calculating dividends, loan interest, handling, company reserves, mortgage loans, calculating payments and recording, supplementary contract calculations, group proposals, and some scientific analysis (projection on mortality studies). Most jobs require a master record and then a periodic updating.

Northern Natural Gas Company

Located in the main office building of the Northern Natural Gas Company at Omaha, the system is used for calculation of gas measurement through monthly delivery statements, payment for gas purchase including royalty interest payments, gas sales summaries for billing, sales statistics and analyses, sales forecasting, gas supply prorations, pipe line design, distribution network analysis, gathering system analysis, branch line calculations, and cost estimates.

Nuclear Development Corporation of America

Located at Eastview, N. Y., the computer is used for scientific computations of interest to the design of nuclear reactors. On occasion, problems arising in other fields are investigated. Little or no accounting work is done on this computer.

The Ohio Oil Company

Located at the Ohio Oil Company, Denver Research Center, Littleton, Colorado, the system is used to perform research on seismic interpretation methods, secondary recovery techniques, fundamental studies on fluid flow through porous media, reservoir analysis, geologic exploration methods, refinery simulation and optimization, development of refining and petro chemical processes, and new geophysical methods.

Pacific Power & Light Company

Located at Public Service Building, Portland, Oregon, the system is used for customer billing and accounting, payroll, stockholders, sales analyses, rate analyses, and engineering problems.

United States Steel Corporation

Located at the Research Center, Monroeville, Pennsylvania, the system is used for computations for statistical analysis, computations for operations research problems, simulation of processes, and design computations.

Western Electric Company, Inc. I

Located on the 1st Floor, 1600 Osgood Street, North Andover, Massachusetts, the system is used for pay-

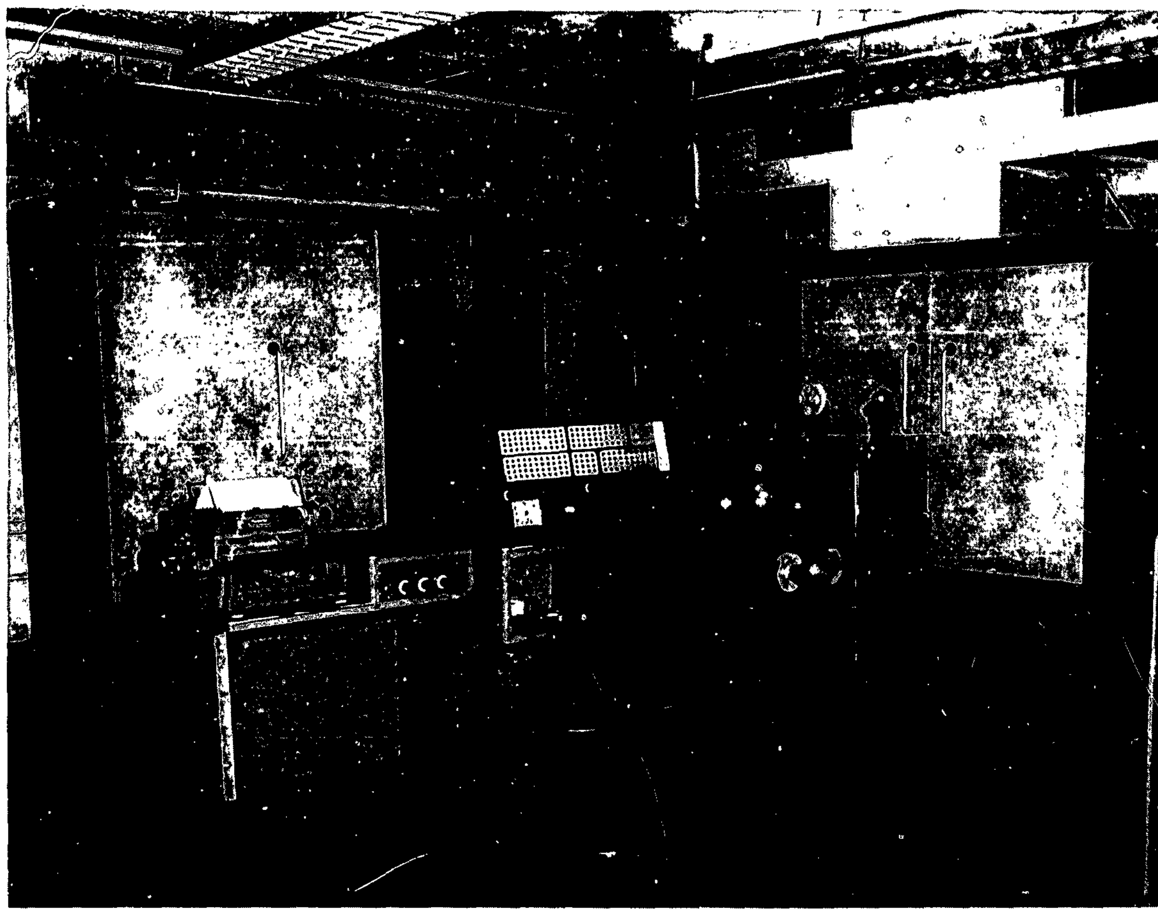


Photo by the U. S. Navy Mine Defense Laboratory

roll and associated record keeping and reports, cost accounting, payments to suppliers, credit union, and scientific applications.

Western Electric Company, Inc. II
Located on the 1st Floor, 1600 Osgood Street, North Andover, Massachusetts, the system is used for production control, component assembly analysis and parts explosion, requirements forecasting, and storeroom inventory.

Westinghouse Research Laboratory
Located at the Westinghouse Research Laboratory, Pittsburgh 35, Pennsylvania, the system is used for scientific computation to solve research problems in fields of math, physics, metallurgy, mechanics, etc; simulation of special purpose control devices to imprive their design; statistical computations in connection with design of experiments, analysis of data, etc; and solution of problems in mathematical economics.

University of Nebraska
Located in Nebraska Hall at the University of Nebraska, Lincoln, Nebraska, applications include engineering mechanics, chemistry and chemical engineering, physics (cosmic rays, solid state, etc), and statistical analyses in the fields of Psychology, Sociology, Animal Genetics, Agronomy, Educational Psychology, etc.

University of Denver
Located in Conrad Hall, Denver Research Institute, the system is used for scientific and engineering problem solution and education.

University of Virginia
Located in the Physics Building, University of Virginia, the system is for general University use.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal
Decimal digits/word	10 plus sign
Decimal digits/instruction	2 to 10
Instructions/word	1
Instructions decoded	83
Arithmetic system	Fixed and floating point
Instruction type	One address
Number range	Floating $10^{-51} \leq N \leq 10^{49}$
	Fixed $+(1-10^{-10})$ to $-(1-10^{-10})$

Instruction word format

S	1	2	3	4	5	6	7	8	9	0
±	Control Digits				Oper Code		Address			

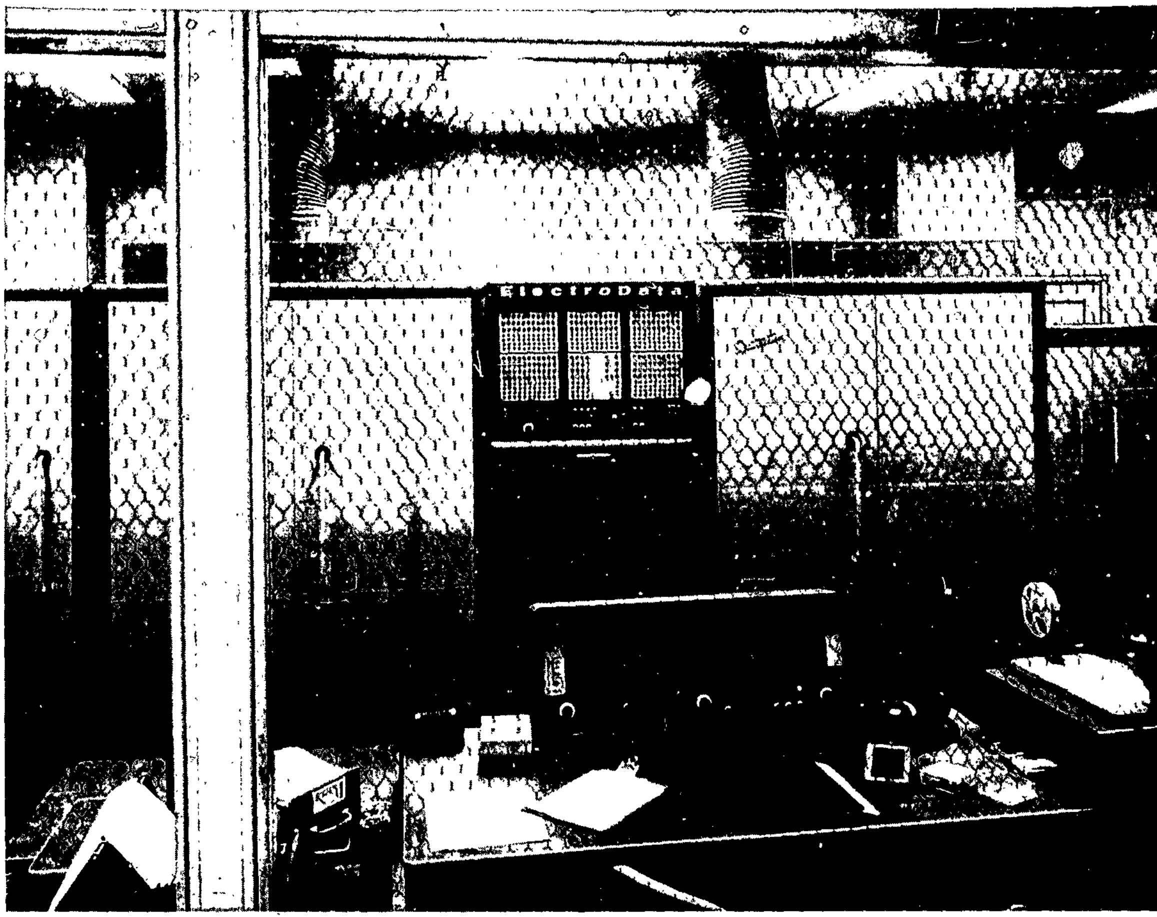


Photo by the U. S. Navy Radiological Defense Laboratory

Automatic built-in subroutines may include special order of table lookup command.

Automatic coding includes Data Code 1, a compiler; Star 0 Assembly Routine; SAC Assembly Routine; Purdue Compiler; Shell Symbolic Assembler; Tape Subroutine Compiler; Shell-Bell Interpreter, etc.

Registers and B-boxes

Registers in the Burroughs 205 consist of the A-Accumulator, capacity of 10 digits and sign which holds arithmetic operand and result. The R register, 10 digits, acts as an extension of the A register where necessary. D register, 10 digits and sign, acts as distributor for transfers to and from storage. C or Control Register, 10 digit register containing command currently being executed. B Register, a four digit register used for modification and tally. All registers act as temporary high speed storage for either arithmetic quantities or control.

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	1,019 or 1,188	
Mult	9,300 mean	8,450 mean
Div	12,680 mean	11,830 mean

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	4,080	40,800	850 (Quick)
Magnetic Tape	400,000	400,000,000	240,000,000
Datafile	2,000,000	20,000,000	24,000,000

Access time is for entire contents. Quick access loops store 80 words, (four 20-word loops). Access time can vary from 84 to 16,800 microseconds depending on position of drum at start of computer command. Datafile is two channel tape, 10,000 addressable blocks/channel, 20 words/block. Datafile gives random access search in either direction. Computation continues suring search.

Magnetic Tape

No. of units that can be connected	10 Units
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	12 Tracks/tape
Blank tape separating each record	0.38 Inches
Tape speed	60 Inches/sec

Photo by General Electric Company, Rome, Georgia

Transfer rate	6,000 Char/sec
Start time	168 Millisec
Stop time	16 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	0.75 Inches
Length of reel	2,500 Feet
Composition	Plastic Base

Twelve channels are recorded across the width of the tape. Of the twelve, only six are read or recorded at one time. The six channels are called a lane. The six channels or one lane are interlaced with those of the other lane. Each of the two lanes has its own read-write head. 400,000 words are on each reel of magnetic tape.

The following installations utilize Magnetic Drum, Data File (Bin), and Magnetic Tape:

BNS	Burroughs
USNOL Corona	USS
Griffiss AFB	WRL
AIC	

The following installations utilize Magnetic Drum and Magnetic Tape:

USN MDL	ITT
USN USL	NDCA
NASA ARC	OOC
ATIC W-P	PP & LC
Little	WE
GICA	

The following installations utilize Magnetic Drum and Data File (Bin):

MMLIC	WE

The following installations utilize Magnetic Drum only:

ABMA	CGC
ARGMA	GE Rome, Ga.
USA CC	KSC
USN HO Washington	Linde
USN RDL	LA
AMIC	NNG
B & W Alliance	U of N
B & W Lynchburg	U of D
CCC	U of V

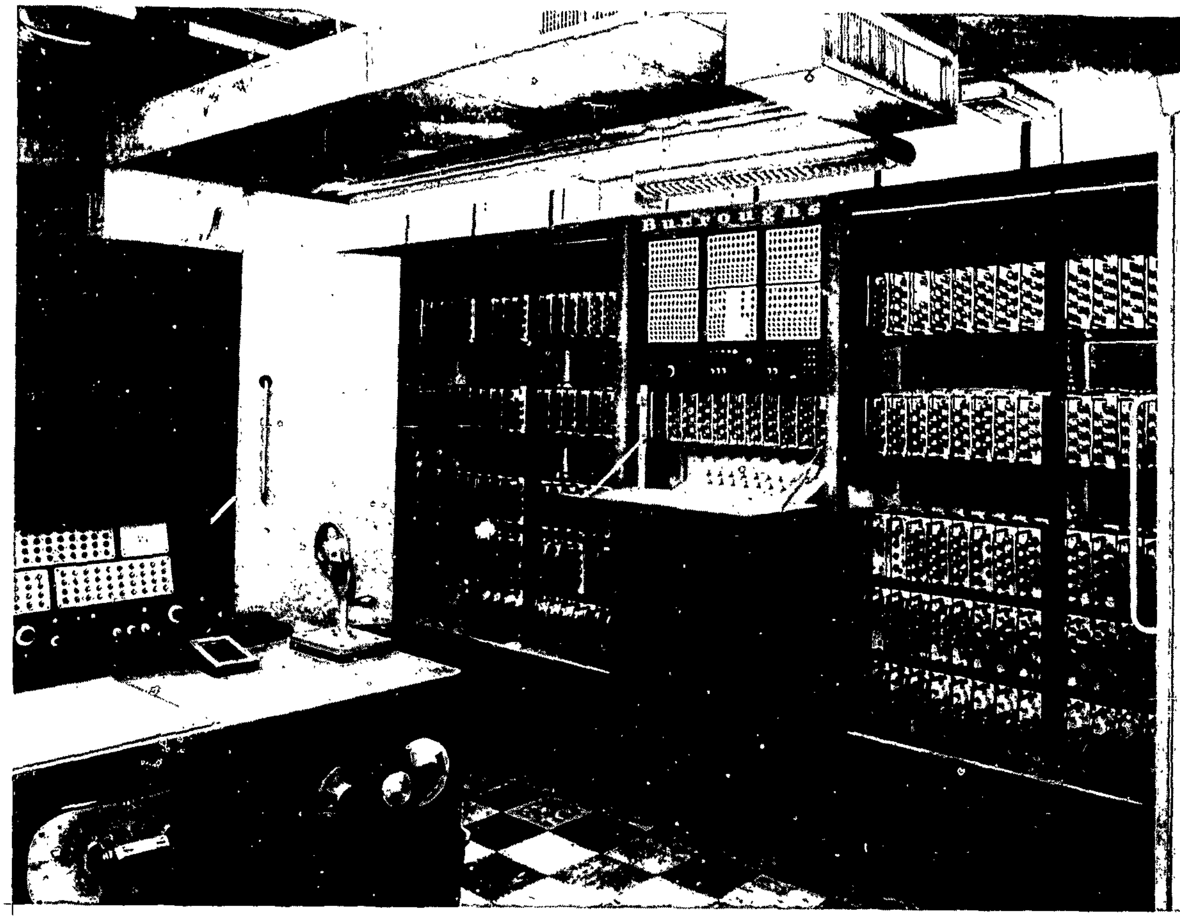


Photo by the Linde Company

INPUT

Manufacturer Media	Speed
Paper Tape	540 digits/sec
Keyboard	Manual
Magnetic Tape	6,000 digits/sec
Cards	400 digits/sec each reader

Up to seven card readers per system may be used.

The following installations utilize Magnetic Tape, Paper Tape, Punched Cards and usually have a Manual Keyboard as input media (Paper Tape systems are high speed photo-electric readers):

ABMA	GE Rome, Ga.
BNS	GICA
USN HO Washington	NNG
USN USL	OOC
AIC	PP & LC
Little	WE System I
Burroughs	WE System II
CGC	

The following installations utilize High Speed Paper Tape, Punched Cards, and M l Keyboard:

USN MDL	Griffiss AFB	CCC	U of N
USNOL Corona	NASA ARC	KSC	
USN RDL	ATIC W-P	MMLIC	

The following installations utilize Magnetic Tape and Punched Cards as input media:

AMIC

The following installations utilize Magnetic Tape and Paper Tape as input media:

NDCA	WRL

The following installations utilize Paper Tape as an input medium:

USA CC	USS
B & W Alliance	U of D
ITT	U of V
Linde	

The following installations utilize Punched Cards as an input medium:

B & W Lynchburg	LA

Photo by the Minnesota Mutual Life Insurance Company

OUTPUT

Manufacturer Media	Speed
Electric Typewriter	10 char/sec
Punched Paper Tape	60 digits/sec
Magnetic Tape	6,000 digits/sec
Punched Cards	1,800 char/min
Printer	150 lines/min

Up to seven printers and/or punch card machines may be included per system. Figures are given for each unit. Units can be parallel for increased over all speeds. Printer is an IBM 407 Tabulator.

The following installations utilize Magnetic Tape, Paper Tape, Punched Cards and usually have an electric typewriter as output media:
ABMA (5)
BNS
USN HO Washington (plus printer)
USN MDL (plus printer)
USNOL Corona (plus printer)
USN USL (plus printer)
Griffiss AFB (plus printer)
NASA ARC
ATIC W-P
AIC (plus printer)
Little (plus printer)
Burroughs (plus printer)
CGC (plus printer)
GE Rome, Ga. (plus printer)
GICA (plus printer)
NNG (plus printer)
OOC (plus printer)
PP & LC (plus printer)
WE System I (plus printer)
WE System II (plus printer)

The following installations utilize High Speed Paper Tape and Punched Cards:
USN RDL (plus printer)
CCC
KSC (plus printer)
MMLIC (plus printer)
U of N

The following installation utilizes Magnetic Tape, Punched Cards and a Printer as output media:
AMIC

The following installations utilize Magnetic Tape and Paper Tape as output media:
ITT
NDCA
USS
WRL

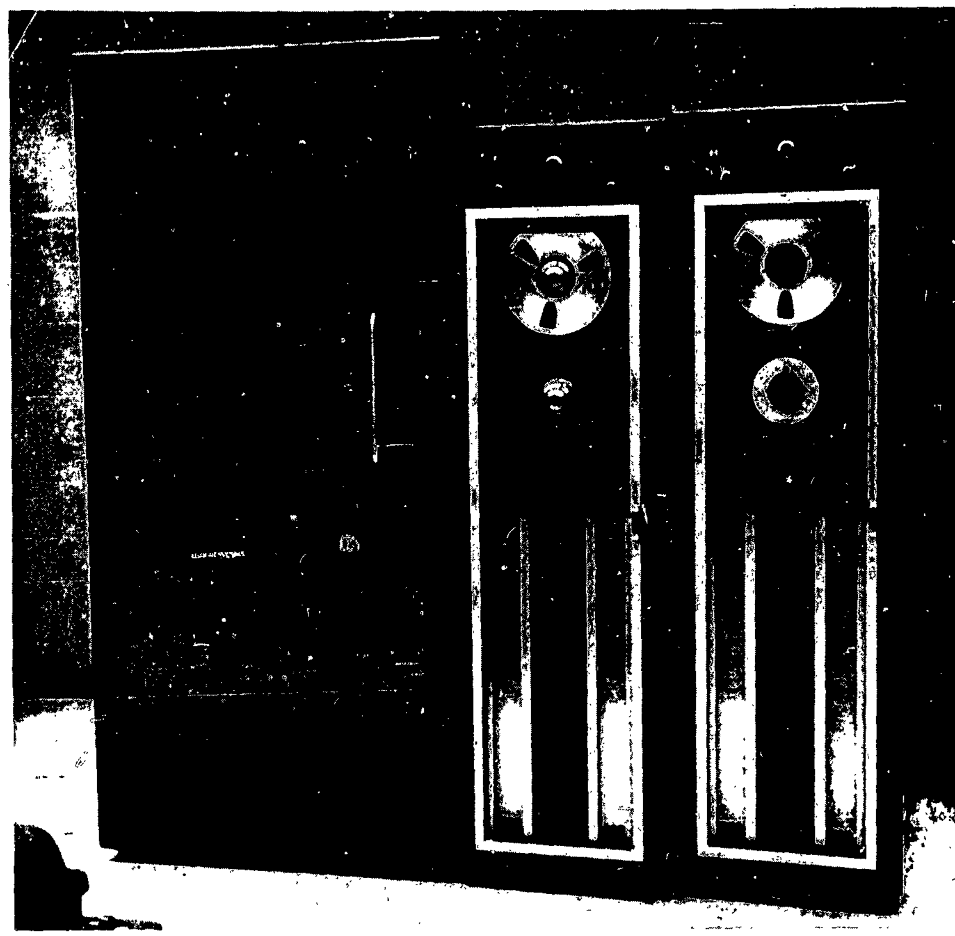


Photo by the Ohio Oil Company

The following installations utilize Paper Tape as an output medium:

B & W Alliance	U of D
Linde	U of V

The following installations utilize Punched Cards as an output medium:
B & W Lynchburg (plus IBM 402 Tab)
LA (plus printer)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity
Tubes	Approx. 1,202
Diodes	Approx. 3,800

CHECKING FEATURES

Manufacturer

Fixed:

The Burroughs 205 automatically stops upon the appearance of an unanticipated overflow. An alarm light is turned on and computation is stopped by a forbidden combination (binary-coded decimal digit 10 thru 15) in the A, B, D, and R Registers, the Address Register, Control Counter, and Shift Counter. Inspection of the registers on the Control Panel indicates the failure location. An alarm stops the computer if the storage cell counted does not contain all zeros at the start of each drum revolution. This prevents information from being recorded on or read from incorrect locations on the drum. An audible alarm indicates excessive rise in exhaust air temperature in the computer cabinet. After a pre-set interval, up to 15 minutes, DC voltage will be shut off if the temperature stays at or above a predetermined level.

Optional:

The marginal voltage test panel facilities selective lowering of voltages in registers and control section, which, in conjunction with test routines, can detect marginal components before they give trouble in actual operation. Supervisory test panel on front of computer has extensive controls and check features, including access to any flip-flop for manual setting, substitution of manual or low frequency pulse operation for the drum clock, and a switch panel which allows maintenance personnel to force abnormal register behavior and to inhibit certain normal checking functions for diagnostic purposes. Contents of all registers are displayed simultaneously at all times.

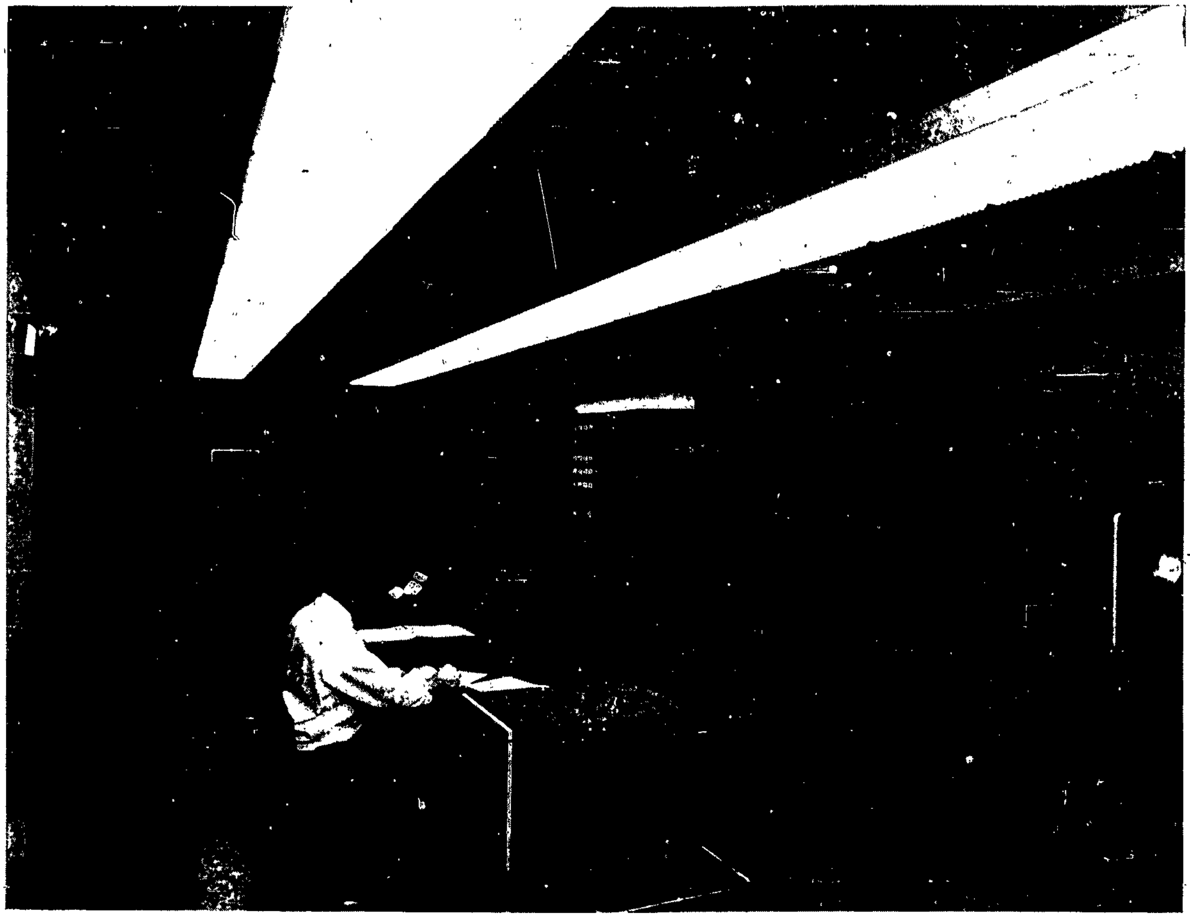


Photo by the Pacific Power and Light Company

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	16.5	KVA
Volume, computer	181	cu ft
Area, computer	28	sq ft
Weight, computer	3,175	lbs

Special flooring is recommended for the Burroughs 205 System to handle the combined and individual weight of the units and to accommodate the inter-cabling. Since all units of the system are designed to have their cables enter from underneath their cabinets, raceways or ducts in the floor are recommended to accommodate the inter-cabling. There are three types of floors which have been found to be completely satisfactory: (1) raised floor, (2) existing floor with built in cable raceways, and (3) existing floors with cables underneath enclosed in metal conduit. The area should provide adequate lighting, some acoustical treatment, communication equipment, and convenience of access to the equipment. The power line should not be serving other heavy equipment which may generate excessive voltage fluctuation. Vibration from such heavy machinery in the vicinity of the system could shorten the life of certain sensitive components. There should be adequate space to accommodate the necessary refrigeration equipment, and the area should lend itself economically to complete air conditioning. Amount of air conditioning depends upon size of computer system installed. For every 12,000 BTU/hour generated by the system one ton of refrigeration is recommended. Environmental condition should also be taken into consideration. The floor load in the computing center can range from 175 to 200 lbs per sq ft and up to 250 per sq ft under the power supply unit. The site selected for the computing center must have a floor which can support the combined weight of the system as well as the localized weight at each leveling point on the units.

ABMA (5)

Power, computer	31.5 Kw	45 KVA	0.7 pf
Volume, computer		11,200 cu ft	
Area, computer		700 sq ft	
Room size, computer		700 sq ft	
Capacity, air conditioner		15 Tons	
Weight, computer		18,370 lbs	

ARGMA

Power, computer	22.7 Kw
Power, air conditioner	11.9 Kw

Photo by the United States Steel Corporation

Room size, computer	25 ft x 25 ft
Floor loading	92.75 lbs/sq ft
	822 lbs concen max
Capacity, air conditioner	15 Tons

Site modification consisted of additional transformer for power, raised floor (locally constructed), air conditioning mounted outside - piped in, and building is of concrete construction.

USA CC

Room size, computer	30 ft x 24 ft
Capacity, air conditioner	25 Tons

False floor

BNS

Power, computer	52.78 Kw
Room size, computer	70 ft 6 in x 22 ft 5 in
Capacity, air conditioner	60 Tons

Existing room for EDPM required new suspended acoustical metal ceiling w/new fluorescent lighting system, new air conditioning system, diffusers, air return registers, plenum system built above ceiling, new vinyl tile floor on existing concrete floor w/recessed conduit chases serving machines. Existing brick walls repainted, new office partitions and new masonry door openings and fire resistant doors installed.

Existing room for air conditioners required new interior partitions (movable), 2 new exterior double doors, repainting, new concrete floor slab and equipment pads, exposed duct system with exterior wall intakes and exhausts, and new lighting.

Power distribution: 400 ampere capacity, 120/208 volts, 3 phase, 4 wire.

USN HO Washington

Power, computer	44.7 KVA at 208V
	12.0 KVA at 115V
Room size, computer	42 ft x 30 ft x 11 ft
Room size, air conditioner	8 ft x 10 ft x 10 ft
	6 ft x 18 ft x 25 ft
Floor loading	175-200 lbs/sq ft
	250 lbs concen max

The site preparations required prior to installation of the Burroughs 205 were raised flooring, the building air conditioning system was "piped in" to the computer room and supplemented by an additional 7 1/2 ton unit; and necessary power lines were brought into the area. The building air conditioning system is 125 tons capacity. It is estimated that the computer realizes only about 1/5 of the available cooling.

Photo by the Westinghouse Research Laboratory, Pittsburgh

USN MDL

Power, computer	15 KVA at 208V
	1.5 KVA at 120V
Room size, computer	1,040 sq ft
Capacity, air conditioner	23.5 Tons

Air conditioning supplied from central system with additional capacity supplied in computer room. The building in which the computer is located is a fireproof, block, steel, and concrete structure. Room modifications were (1) one 208 power supply and 10 individual 120V supplies, (2) air conditioning ducts installed at the ceiling around 2 walls with 10 exhausts, (3) a false floor was constructed over one half the floor area raising the computer approximately 6 inches.

USNOL Corona

Power, computer	49.0 KVA
Power, on-line equipment	11.1 KVA
Room size, computer	132 1/2 ft x 28 1/2 ft x 10 ft
Room size, air conditioner	36 ft x 11 1/2 ft x 8 ft
	16 ft x 20 ft x 8 ft

Site preparations included a secondary floor to provide concealed power cable raceways and safety for operating personnel, an air conditioning system, including a small building for housing air compressors and condensing coils, and power distribution panels and conduit.

USN RDL

Power, computer	42 Kw	60 KVA	0.7 pf
Power, air condi	16.7 Kw	20.9 KVA	0.8 pf
Area, computer		135 sq ft	
Room size, computer		22 ft x 48 ft	
Capacity, air conditioner		15 Tons	

Unit installed in open area of existing building. Movable partitions, 15 ton air conditioner with duct distribution system, humidifier, power distribution system, and cable raceways were installed.

USN USL

Power, computer	30.4 KVA
Room size, computer	34 ft x 20 ft
Floor loading	125 lbs/sq ft
	2,000 lbs concen max
Capacity, air conditioner	20 Tons

Site preparation included shoring of floor to handle increased load, installation of air conditioning, and a separate power service.

NASA ARC

Area, computer	1,450 sq ft
Area, air conditioner	550 sq ft
Floor loading	260 lbs concen max
Capacity, air conditioner	50 Tons

Figures are for 2 systems in one room. The com-

Photo by the University of Denver

puters are located on 2nd floor on 2 story concrete building. Power distribution and computer cabling is done through false ceiling of lower floor. As the computing facility expanded, it was necessary to install hoods on both main frames and vent the hot exhaust through the ceiling.

ATIC W-P

Power, computer	15 Kw
Power, air conditioner	10 Kw
Capacity, air conditioner	20 Tons

A false floor was constructed. Cool air is fed directly into the room.

Little

Power, computer	38.2 KVA
Power, air conditioner	5.0 KVA
Capacity, air conditioner	20 Tons

Installed on first floor of new building with waterproof raceways for power cables.

AMIC

Raised floor (plenum).

B & W Alliance

Power, computer	20.1 KVA
Room size, computer	25 ft x 22 ft
Floor loading	85 lbs/sq ft
	2,700 lbs concen max

Room was provided by using movable partitions, floor to ceiling. Floor was trenched for cables. Air conditioning system was installed with ducts above ceiling, supply plenum and return over computer, ceiling diffusers over other components. Separate transformer installed for isolated power source. Building stairs and floor were braced while moving computer into the building.

B & W Lynchburg

Power, computer	41.3 KVA
Room size, computer	700 sq ft
Capacity, air conditioner	15 Tons

False flooring and air conditioning were added.

Burroughs

Power, computer	50.3 Kw	55.9 KVA	0.90 pf
Floor loading	175-200 lbs/sq ft		
	250 lbs concen max		

False floor with normal air conditioning piped through floor and ceiling.

CGC

Power, computer	50.2 KVA
Room size, computer	1,300 sq ft
Floor loading	110 lbs/sq ft
Capacity, air conditioner	36 Tons

An elevated floor (plenum for air to equipment), false ceiling (to provide return for air power separated from general building), and air conditioning chamber were added.

GE Rome, Ga.

Power, computer	56.4 KVA
Capacity, air conditioner	22.5 Tons Overhead hung

Installed concrete floor 4.5 inches over existing floor with ducts approximately 8 inches wide to accommodate cables. Installed 3 air conditioning units, 7.5 tons each. Installed one humidity control unit.

GICA

Power, computer	36.6 KVA
Room size, computer	26 ft x 36 ft
Capacity, air conditioner	25 Tons

Raise floor, put in cable troughs. Drop ceiling. Enclose area in glass. Bring in 3 phase 230 power.

ITT

Power, computer	26.6 KVA
Room size, computer	20 ft x 30 ft
Capacity, air conditioner	22 1/2 Tons

200 amp 208V 3 phase line. Raised floor with movable segments. 15 tons of recirculating air conditioning (7 1/2 tons already in room provides all fresh air). Partitions separating computer, from programmers. Twelve foot display window.

KSC

Power, computer	23 KVA at 208V
	6 KVA at 115V
Capacity, air conditioner	18 Tons

Used existing 1,100 sq ft frame stucco building with concrete slab floor. Sealed all openings and installed 1 7 1/2 ton roof air conditioner. 1 7 1/2 ton interior upright air conditioner and 1 3 ton window-type air conditioner-all refrigeration. Brought in power from nearby heavy duty substation and installed transformer.

Linde

Power, computer	24.1 KVA
Room size, computer	32 ft x 16 ft
Capacity, air conditioner	10 Tons

LA

Capacity, air conditioner	75 Tons

When building was built, a special 6 ft thick waterproof, floating type foundation was installed. A motor-alternator was added for power constancy later. A separate power line is being considered. Special air conditioning facilities were designed.

MMLIC

Room size, computer	1,775 sq ft

False ceilings, raised vermicolite floor with built-in raceways, full air conditioning and power.

NNG

Power, computer	50 KVA
Room size, computer	30 ft x 48 ft
Capacity, air conditioner	25 Tons

Raised flooring (Bel Air) and new power supply line were added.

OOC

Power, computer	22.4 KVA
Capacity, air conditioner	15 Tons

Room designed and constructed to house computer. Room has poured concrete floor with crawl space beneath for cables, air conditioning ducts and motor generator set. Conditioned air is fed directly to main frame of computer and is exhausted into plenum chamber in ceiling. The chilled water air conditioning unit is in a location separate from the computer room.

PP & LC

Power, computer	76 KVA
Power, air conditioner	57 KVA
Room size, computer	30 ft x 52 ft
Room size, air conditioner	30 ft x 30 ft
Capacity, air conditioner	25 Ton Units (2)

Put in 4 inch raised floor to provide space for interconnecting cables, etc. Installed air conditioning. Put in separate power circuit to help assure constant voltage.

USS

Power, computer	24.2 KVA at 208V 5.7 KVA at 115V
Room size, computer	21 ft x 39 ft
Capacity, air conditioner	15 Tons 105,000 BTU/hr.

System installed in building recently erected to house this and other research facilities. All requirements for computer installation were handled during building design. False floor in computer laboratory serves as plenum for air conditioning system.

WE Systems I and II

Power, computer	49.0 KVA
Room size, computer	1,500 sq ft
Capacity, air conditioner	13.5 Tons used by computer

Figures are for each system. Site preparations included building type (basement section of office building - no modification to basic structure), ceiling (air conditioning input plenums installed in center with cool air entering through perforations, exhaust at periphery), and floor (8" raised floor with ramp to normal level - accommodates all power and component distribution cables) for each system.

WRL

Power, computer	28.8 Kw	32 KVA
Power, air condit	7.0 Kw	8.8 KVA
Room size, computer		30 ft 6 in x 21 ft x 9 ft
Capacity, air conditioner		15 Tons

Trenches were dug in the floor. MG set installed.

U of N

Power, computer	15 KVA
Capacity, air conditioner	11 1/2 Tons

False ceilings and cable raceways were installed. Building is of reinforced concrete.

U of D

Power, computer	21.5 KVA
Capacity, air conditioner	10 Tons

Reinforced floor, false floor (air conditioning), plenums (air conditioning), and separate power for computer were installed.

U of V

Power, computer	21.0 KVA
Capacity, air conditioner	12 Tons

Large area in basement of building was modified to accept the computer, offices, etc.

PRODUCTION RECORD

Manufacturer

Number in current operation	112
Time required for delivery	4 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Purchase Price	Monthly Rental
Computer, Model 205 Includes cabinet, plug-ins, and 4080 word magnetic drum memory with read-write heads. Also includes Magnetic Electronic Power Supply and Power Control Units.	$135,000	$3,900
Control Consoles Include decimal keyboard, displays of the computer registers, and computer controls. (Control Console Model 406 or 409 is required with a computer system that includes Cardatron.)		
Control Console, Model 406 Includes both a photo-electric reader and a high speed punch (60 characters per second).	14,210	490
Control Console, Model 409 Includes a photo-electric reader only.	11,230	362
Control Console, Model 403 The photo-electric reader and high-speed punch are not included.	7,050	230
Control Console, Model 402 Performs the same functions as the Model 406, except that the punch perforates paper tape at the rate of 20 characters per second.	13,270	423
Consolette, Model 405 Includes decimal keyboard, essential computer controls and indicators, but does not include displays of the computer registers.	1,980	70
Typewriter Control, Model 446 Usable with all consoles, the typewriter control includes the stand which supports the Flexowriter and contains external format control equipment and a relay translator.	4,560	137

	Purchase Price	Monthly Rental
Modified Flexowriter, Model 458 Incorporates the correct code for alphanumeric print-out under computer control; both a tape punch and a tape reader are attached to the Flexowriter. The tape reader may be used for a slow input to the computer.	$ 3,135	$ 95
Tape Perforator & Verifier, Model 454 Includes a decimal keyboard, tape perforator, and tape reader. Used to prepare, verify, or automatically duplicate numeric, perforated tape.	3,790	133
Numeric Code Converter, Model 460 Provides conversion, digit by digit, from one punched paper tape code to another. Includes a motorized tape reader, motorized tape punch, and two matrix cards (ElectroData to teletype and teletype to ElectroData code).	3,680	110
Matrix Cards for other codes	395 ea	15 ea
External Switching & Output Selector, Model 420 Permits the 500 Punched Card Converter to operate with either an IBM tabulator or summary punch as selcted by computer programming.	4,375	155
External Switching, Model 421 Provides selective switching to eight external sources as directed by the computer program, but does not include the output selector unit for use with the 550 Punched Card Converter.	2,890	105
Punched Card Converter, Model 500 Permits use, under computer control, of an IBM summary punch as input and an IBM tabulator or gang punch as output.	18,625	567
Cardatron, Model 506 Control Unit & Auxiliary Power Supply	31,000	770
Input Unit, Model 507	22,500	560
Output Unit, Model 508 (80 character)	26,300	660
Output Unit, Model 509 (120 character) (maximum number of input/output units: seven) Permits simultaneous high-speed communication between standard punched card machines and the 205 Computer. Alphabetic, special, and numeric characters may be intermixed in any manner.	27,550	690
Magnetic Tape Control, Model 547 Master control unit which provides electronic control for any combination of up to ten magnetic tape units and Datafiles.	28,000	875
Magnetic Tape Unit, Model 548 Reel-type magnetic tape storage, includes read-write heads and tape drive mechanism and operates under control of magnetic tape control.	13,500	425

	Purchase Price	Monthly Rental
Datafile, Model 560 Multiple magnetic tapes for data storage under control of the Magnetic Tape Control, Model 543 or 547. Includes drive mechanism for 50 lengths of tape (100 logical tapes), partitioned bin, and read-write heads. Tapes are brought out over guide rods and the two recording heads are servo positioned under the selected tape.	$ 25,000	$ 825
Floating Point Control, Model 360 Provides automatic floating-point arithmetic for the operations of addition, subtraction, multiplication, and division.	21,200	725

Burroughs Line Printer, Model 289
For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch Two triple panel manual plugboards Five 2-position pilot selectors Eight 5-position co-selectors Five 4-position Cardatron selectors Two digit selectors Twenty symbol selectors One half-time emitter Ten filters Six carriage skipping channels and one overflow channel Pluggable zero and asterisk print control	36,000	850

Optional Features:		
Group of five 2-position pilot selectors	250	10
Group of four 5-position co-selectors	200	5
Group of ten symbol selectors (maximum two groups)	600	15
Group of two digit selectors	200	10
Group of ten filters	70	3
Additional plugboard	100	

Burroughs Card Output Unit - Model 292
For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch Six 5-position co-selectors Five 2-position Cardatron selectors One digit emitter One half-time emitter One single panel manual plugboard	5,800	150

Optional Features:		
Double punch and blank column detection device (Group of 20-positions-maximum four groups)	740	16
Offset stacker	225	10
Additional plugboard	50	

Burroughs Card Input Unit, Model 293
For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch Five 2-position pilot selectors Eight 5-position co-selectors	14,000	300

Two digit selectors
One half-time emitter
One single panel manual plugboard

Optional Features:

Group of five 2-position pilot selectors	250	10
One additional digit selector	200	10
Additional plugboard	50	

All prices are subject to change without notice.

Outline of lease policy

Basic monthly rental entitles the customer to a maximum of one hundred and seventy-six (176) hours of use time during each calendar month. Use time of each system component in excess of one hundred and seventy-six (176) hours will be chargeable at the rate of forty percent of the hourly basic rental. The hourly basic rental is 1/176th of the basic monthly rental. Extra use charges will be computed to the nearest half hour.

Use time is defined as follows: "The time during which each component is in operation exclusive of preventive or remedial maintenance time. When components are inter-connected and programmed to operate as a system, all such components shall be deemed to be in use for the entire period when any part of the system is operating. Components which are not included in a given program will not have use time accumulated against them even though the components are inter-connected."

The rental rate is effective at or from the date installation of the equipment is complete and remains in effect thereafter until terminated by either party upon ninety (90) days written notice. The lease price includes personal property tax and insurance coverage on the machines; all additional taxes are paid by the lessee. Machines under lease may be purchased at any time at the prices in effect at the time such option less a credit of forty percent of all rental charges (excluding taxes) are paid on the actual equipment purchased, provided that such credit shall not exceed a maximum of sixty percent of the purchase price in effect.

The 88/60 Plan for Rental of Burroughs 205 Data Processing Systems

The reduced rental charges applicable to system orders under the provisions of this option will be sixty per cent of the basic monthly rental charges and will entitle the lessee to use the system up to eighty-eight hours per calender month. Use of the system in excess of eighty-eight hours per month shall be subject to an extra charge at an hourly additional use rate of one per cent of the regular monthly charge.

Use time is defined as the time during which the system or any components thereof is in operation, exclusive of preventive or remedial maintenance time: when system components are normally inter-connected the sum of the regular monthly charges for these components is to be taken as the regular monthly charge for the system in determining the hourly additional use rate.

The customer at his option may convert from the 88/60 rental plan to the normal one hundred and seventy-six hour rental plan. When this conversion is made the customer may not revert to 88/60. Use of the system for more than one hundred and twenty-eight hours per month would make it advantageous for him to convert.

Burroughs will provide the necessary parts and service to maintain the equipment in good operating condition as required during its regular business hours, eight a.m. to five p.m., Monday through Friday excluding holidays.

Burroughs 205 Data Processing System may be of any configuration, the 88/60 plan applies only to on-line equipment. The tape perforaterand verifier model 454, the numeric code converter model 460, and other similar equipment used off-line must be rented at normal monthly rental rates. The Burroughs input-output equipment, models 289, 292, and 293 are not offered at reduced rental. Custom engineering devices on which charge has been established must be rented at the full rental rates.

Debugging allowance for 88/60 is limited to twenty-hours of machine time.

Maintenance/Service Contracting

Burroughs will keep the machines in good operating condition. All costs of maintenance (except for ribbons and supplies) will be borne by contractor unless the required maintenance is due to the fault or negligence of the lessee.

Burroughs shall provide maintenance service during all periods of operation. Upon mutual agreement, contractor will assign "on site" service engineers.

The lessee will provide adequate storage space for spare parts, and adequate working space including heat, light, ventilation, electric current and outlets, for the use of the service engineers. These facilities will be within a reasonable distance of the machines to be serviced and will be provided at no cost to contractor.

Preventive (scheduled) maintenance for each machine will be furnished on a schedule which is mutually acceptable to the lessee and Burroughs and which is consistent with the operating requirements.

Burroughs will always be responsive to the maintenance requirements of the lessee. All remedial (unscheduled) maintenance will be performed promptly after notification to contractor's nearest service location that a machine is inoperative.

If contractor is unable to restore a machine to good operating condition and the machine remains inoperative for a continuous period of 24 hours during scheduled work days of the installation from the time the lessee notifies contractor that the machine is inoperative, and it is determined that (1) the machine became inoperative through no fault or negligence of the lessee, and (2) the lessee's production requirements were interfered with as a result of the machine breakdown, Burroughs will grant to the lessee a credit for each hour the machine was inoperative. Such credit shall be 1/176th of the monthly charge for the inoperative machine plus 1/176th of the monthly charge for an interconnected machine not usable as a result of the breakdown; provided, however, that the credit granted for each machine shall in no instance exceed 1/30th of the monthly charge for the machine in each 24 hour period.

Burroughs will use its best efforts to assist the lessee in procuring service on equipment compatible with that used by the lessee, to meet emergencies such as a major breakdown, conversion from one system to another, unforeseen peak loads, etc. The lessee, at its option, may accept or reject the offer of use of emergency equipment. If accepted, the cost of such services, if any, will be arranged on an individual installation basis.

Lessee shall not be responsible for loss or damage to the equipment caused by fire, lightning, sprinkler leakage, tornado and wind storm, hail, water damage, explosion, smoke and smudge, aircraft and motor vehicle damage, earthquake, collapse of buildings or structures and strikes, riots or civil commotion. Burroughs

Corporation shall provide transit insurance and comprehensive public liability insurance on the equipment.

Burroughs Corporation will furnish prescribed training of customer employees in programming and operating procedures and techniques. Additional services of a staff of qualified programmers, mathematical analysts and engineers to further improve specific utilization of the equipment may be contracted for.

A standard Burroughs Corporation sales or rental agreement will be executed at the time of sale or lease.

Except for expendable items, such as tubes, diodes, fuses, lamps, and neon indicators, all equipment is guaranteed for one year against defective material or workmanship.

ABMA

Rental for 205, 350, 351, 360, 406, 407, 466, 446, 2-458's, 454, 506, 352, 507, 509, 543, 3-544's is $9,470.00 per month.

ABMA

205, 350, 351, 360, 406, 407, 466, 458, 543, 544, 500, 544, 420, 421 rents at $7,537 per month.

ABMA

205, 350, 351, 360, 406, 407, 466, 446, 2-458's, 506, 352, 507, 509, 543, 3-544's rents at $9,647 per month.

ABMA

205, 350, 351, 352, 406, 407, 466, 446, 458, 506, 507, 509, 360, 543, 4-544's, 454 rents at $10,060/mo.

ARGMA

Burroughs 205		$135,000
360		21,200
500		18,625
543		25,000
544 (2)		24,000
406		14,210
420		4,375
458		3,135
446		4,560
IBM 528	$235/month	
IBM 407	800/month	

Maintenance contract with Burroughs in the amount of $20,000 per year.

USA CC

Computer	$3,900/month
Console	490/month
Flexowriter	95/month
Typewriter Control	137/month
Total	$4,622

BNS

Burroughs 205 Computer with Cardatron (1 in, 3 out), 6 magnetic tape units, tape bin file, paper tape reader and punch, Flexowriter, floating point - $12,740/month.

IBM Type 523, 087 and two 407's - $1,992/month.

USN HO Washington

$10,443/month - basic shift - Main frame, console, Flexowriter, 3 tape units, Cardatron input & output, IBM 089, IBM 407 and IBM 523.

USN MDL

Model	Description	Rental	Cost
205	Burroughs Digital Computer	$3,900	$135,000
406	Control Console	490	14,210
500	Punched Card Converter	567	18,625
446	Typewriter Control	137	4,560
458	Modified Flexowriter	95	3,135
454	Tape Perforator & Verifier	133	3,790
543	Magnetic Tape Control	750	25,000
544	Magnetic Tape Storage	375	12,000

Above equipment manufactured by Burroughs Corporation.

All following equipment manufactured by IBM Corp.

Model	Description	Rental	Cost
523	Card Summary Punch	$ 85	$4,300
407	Accounting Machine	800	42,000
010	Card Punch	10	600
024	Alphabetical Punch	40	1,950
026	Alpha Printing Punch	60	3,200
056	Alpha Verifier	50	2,400
077	Card Collator	115	5,500
082	Sorter	85	2,575
402	Accounting Machine	525	24,500
519	Document Originating Machine	251	6,550
552	Alphabetic Interpreter	108	5,500

USNOL Corona

Burroughs - $300,475.

IBM - $1,644.50 per month (on-line equipment)

IBM - $2,608.50 per month (off-line equipment)

Burroughs maintenance/service contracting is $57,404.33 per year.

USN USL

Burroughs Digital Computer Model 205, Control Console Model 406, Modified Flexowriter Model 458, Typewriter Control Model 446 costs $156,905.

Punched Card Converter Model 500, Magnetic Tape Control Model 543, Datareader Model 544, Floating Point Control Model 360, and Tape Perforator & Verifier costs a total of $92,615.

Burroughs Digital Computer Model 205, Control Console Model 406, Modified Flexowriter Model 458, Typewriter Control Model 446 rents for $4,622.

Punched Card Converter Model 500, Magnetic Tape Control Model 543, Datareader Model 544, Floating Point Control Model 360, and Tape Perforator & Verifier Model 454 rents for $2,925.

Griffiss AFB

Burroughs 205 System rents for $10,914/month.

IBM input, output equipment rents for $1,193/month.

Maintenance/service contract included with rental.

NASA ARC

System 107 - Main frame, console, punched card converter costs $120,000.

System 128 - Main frame, console, punched card converter costs $120,000.

System 107 - high speed punch - costs $5,000.

System 128 - magnetic tape, 2 drives, Cardatron (2 input, 1 output), high speed punches - costs $140,000.

Contract with Burroughs Corporation for maintenance on 2-shift basis costs $57,500 per annum.

ATIC W-P

Main frame, console, punched card converter, and 2 tapes cost $275,000.

4 extra tapes cost $62,000.

3 full time personnel contracted at $47,000 for maintenance.

Little

Computer, control console, typewriter control, and Flexowriter cost $156,905.

Cardatron (Card input & output, printer)	$107,350
Magnetic tape control, 2 tape units	49,000
Peripheral IBM equipment (attached)	68,000

Computer, control console, typewriter control, and Flexowriter rents for $4,582.

Cardatron, magnetic tapes, and IBM equipment attached rents for $5,500.

Maintenance included in rental price. Service on purchased equipment - basic system - $867/month; additional equipment - $1,950/month.

B & W Lynchburg

205, 403, 500, 543, 544, (2) 360 cost $260,000. Additional equipment are IBM 402, 514, 523, and 80. 205, 403, 500, 543, 544 (2) 360 rent for $6,500. IBM 402, 514, 523, and 80 rent for $650.

CGC

1-205 Burroughs, 1-409 Console, 1-446 Typewriter Control, 1-458 Flexowriter, 1-543 Tape Control, 2-544 Datareaders, 1-560 Datafile, 1-506 Cardatron Control, 1-507 Cardatron Input, 1-509 Cardatron Output; purchase price $308,975 - lease $8,839 per month.

1-087 Collator, 1-407 Tabulator, 1-514 Reproducer, 1-082 Sorter, 3-026 Keypunch, and 2 NCR Add Punches cost $88,000.

Basic system rents for approximately $8,840 per month.

Other equipment rents for approximately $1,500 per month.

GE Rome, Ga.

Computer system, 4 tape transports, Cardatron System (1 input, 2 output), floating point, and tape control unit rents for $9,815/month.

GICA

Central computer (205), console with optical reader and tape punch, Flexowriter, typewriter control and power supply costs $156,905.

Cardatron System: Control, 2 input and 2 output; 2-523, 1-407, 1 tape control, and 4 tape storage units cost $240,500.

Rental rate for 2-089's and 1-407 is $1,280.

Maintenance/service contract is $32,000/year.

ITT

Computer, floating point, magnetic tape, 2 Flexowriters, punch, etc. rents for $7,400.
Maintenance is included in rental.

KSC

205 Computer, power supply, Cardatron, F. P. unit rents for $8,057/month.

Input-output IBM equipment rents for approximately $1,800/month.

Linde

$5,712 basic rental per month.

LA

Main frame, floating decimal, and Cardatron Input-Output rents for $6,085/month.

MMLIC

Power supply, computer, tape control, 7 tape units, card control, 1 card input, and 2 card output costs $356,000.

IBM 523, IBM 407, and IBM 089 rents for $60,000.

NNG

205 central processor with Cardatron (one input-two output), magnetic tape (3 units), and paper tape in and out rents for $8,300/month.

IBM 089, 523, and 407 rents for $1,200/month.

Maintenance contract is included in rental.

NDCA

Computer and 2 tape units cost approximately $200,000. Own maintenance is performed.

OOC

Computer, console and photoelectric reader, Flexowriter and control, automatic floating point unit, magnetic tape control unit, two tape transport units, power control unit, punched card converter and tape preparation unit cost approximately $230,000.

IBM 082 Card Sorter costs $650.

IBM 087 Collator, 402 Accounting Machine, 026 Printing Card Punch and 523 Summary Punch rents for approximately $650/month.

Own maintenance on computer is performed.

PP & LC

$313,000 for computer, including power supply unit; Input and Output Cardatron Control, 1 input, 2 output Cardatrons; Magnetic Tape Control and 6 Magnetic Tape Units; Flexowriter, Photoelectric punched paper tape reader; high speed paper tape punch,

$57,000 for maintenance equipment, parts and tools, magnetic tape, cabinets, files, shelves, furniture, etc.

IBM 407, 523, and 089 rent for $1,250/month.

Maintenance contract is $2,500/month.

USS

	Cost	Monthly Rental
Central Computer, power supply, power control, console, optical reader, tape punch, Flexowriter, Flexowriter format control, tape preparation unit	$164,905	$4,902
Magnetic tape control, tape transports (2), Datafile (1), floating point unit, Flexowriter, Flexowriter format control	102,895	3,282

Maintenance included in rental costs (resident service engineer).

WE System I

Basic System Component	Cost	Monthly Rental
Main Frame & Power Supply Unit	$135,000	$3,900
Console & Photo-electric Reader	14,210	362
Typewriter Output & Control	7,695	232
Total	$156,905	$4,494
Additional Equipment		
"Datafile" Magnetic Tape Unit	$ 25,000	$ 825
"Reel" Magnetic Tape Unit	13,500	1,700(4)
Magnetic Tape Control Unit	28,000	875
Floating Point Control Unit	21,200	725
"Cardatron" IBM Code Conversion Control Unit	31,000	770
"Cardatron" IBM Conversion Output Unit	26,300	1,380(2)
"Cardatron" IBM Code Conversion Input Unit	22,500	560
IBM 089 Collator (Input)	13,200	228
IBM 523 Punch (Output)	4,300	121
IBM 407 Printer (Output)	48,000	913
Total	$233,000	$8,097

"Reel" Magnetic Tape Unit cost $425 each; and "Cardatron" IBM Code Conversion Output Unit cost $690 each.

Second unit is the same except it does not include the floating point control unit.

WRL

Central computer, power control, motor generator, control console, with photoreader and high speed punch, Flexowriter and control costs $157,000. Floating point unit, two magnetic tape units, 1 Datafile, magnetic tape control, 2nd Flexowriter, paper tape preparation unit costs $106,000.

U of N

Burroughs 205, punch card converter, console and high-speed punch, typewriter control, two Flexowriters, oscilloscope, test equipment, etc. cost $185,000. IBM 528, 024, and 056 rents for about $3,000/year. $957 is the monthly charge by Burroughs Corporation for maintenance.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	1	1
Analysts	3	3	3
Programmers	4	4	4
Librarians	1	1	1
Operators	2	3	4
Engineers	1	2	3

The contractor, without cost to the lessee, will train an adequate number of operating and programming personnel including the initial staff and replacements at the contractor's training locations or, if mutually agreed to at a lessee location. The contractor's technical personnel shall be available to the lessee for assistance in the implementation, review and improvement of existing data processing systems and for the programming, development and implementation of new systems involving the contractor's equipment.

ABMA

	One 8-Hour Shift
Supervisors	3
Programmers	7
Operators	1

ARGMA

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Programmers	5	7
Operators	1	1
Technicians	1	1

Operation tends toward open shop.

USA CC

	One 8-Hour Shift
Supervisors	1
Analysts-Programmers	4
Coders	7
Operators	1
Engineers	1 Burroughs

Operation tends toward open shop.

Method of training used is formal course held at installation.

BNS

	One 8-Hour Shift	
	Used	Recommended
Supervisors	2	2
Analysts	1	1
Programmers & Coders	11	11

Operation tends toward open shop.

Methods of training used includes manufacturer's courses and on-the-job training.

USN HO Washington

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	3	5
Analysts		4
Programmers	8	9
Clerks	1	1
Operators	3	4

Operation tends toward closed shop (limited open shop).

Methods of training used include on-the-job training and manufacturer courses in programming.

USN MDL

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	1	2
Analysts	3	4
Programmers	4	6
Operators	3	4
Engineers	1	1
Technicians	1	1
In-Output Oper	2	2

Operation tends toward closed shop.

Training has been accomplished by company representatives holding two-week training sessions at this installation. This basic training by close supervision and guidance until experience is gained.

USNOL Corona

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Operators	7	7
Engineers	3	3

Operation tends toward closed shop.

Methods of training used include contractor schools and on-the-job training.

USN RDL

	Two 8-Hour Shifts
Supervisors	1
Programmers	7

USN USL

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	2	4
Programmers	2	4
Operators	1	1

Operation tends toward closed shop.

NASA ARC

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	Used	Rec	Used	Rec	Used	Rec
Supervisors	2	2	2	2	2	2
Analysts	1	1	1	1	1	1
Programmers	6	6	6	8	7	9
Librarians	0	1	0	1	0	1
Operators	1	2	2	3	3	4
Engineers	1	1	2	2	2	2

Operation tends toward closed shop.

Preinstallation training of two engineers and two programmers at computer factory. Subsequent training of programmers and operators has been on-the-job.

ATIC W-P

	One 8-Hour Shift
Supervisors	3
Analysts	4
Programmers	5
Coders	1
Clerks	1
Librarians	2
Operators	3
Engineers	4
In-Output Oper	2

Operation tends toward open shop.

Little

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts		1
Programmers	1	4
Clerks	1	1
Operators	1	1
Engineers	2	1

Operation tends toward open shop.

Courses held periodically on premises on machine language programming, assembly and interpretive programs available. In many instances, staff learns programming techniques by home study. Lab personnel supervise actual training on computer, usually 2-3 hours training required.

ADL is an industrial research consulting firm. Per-

sonnel include mathematicians, physicists, chemists, statisticians, engineers, economists, etc. Since they all work for different clients over a period of months, the problems to be solved vary greatly.

The role of the Computing Lab is to provide a facility for out professional staff for the solution of client problems or research projects and to process all internal accounting information. The wide variety of problems to be solved dictated the necessity of training certain members of each division in the company in computer programming and though their work is primarily in their own specialized fields, they also act as computer consultants when the situation arises. Consequently, there are approximately 40 employees scattered throughout the company with programming experience, not only on our computer but other faster and more versatile ones. When a problem arises in their area, they do the analysis, programming and actual debugging work. Most of the problems solved are one-shot programs either simulating data processing problems such as inventory control, production scheduling, etc., or experimental engineering calculations.

The Lab staff mentioned above is primarily involved in operating and editing accounting programs, training personnel and programming small jobs for members of the staff.

AMIC

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	3	5
Clerks	1	1
Operators	1	1
Engineers	1	1
In-Output Oper	1	1

Operation tends toward open shop.

B & W Alliance

	One 8-Hour Shift
Programmers	1
Coders	1
Clerks	1
Operators	1

Operation tends toward open shop.

B & W Lynchburg

	Two 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	3	-
Programmers	10	-
Coders	8	-
Clerks	1	-
Operators	2	2
Engineers	2	2
In-Output Oper	2	2

Operation tends toward open shop.

Need varies with programming load not machine usage.

One day course in DUMBO autoprogramming system for open shop users. On-the-job training for programmers, coders, (hand computers), and operators.

Burroughs

Since the computer is on the premises of one of the manufacturer's (Burroughs) plants, there is a section responsible for the activities of the three systems within the computer facilities. The three systems are the Burroughs 205, Burroughs 220, and Burroughs E101. The computer facility consists of the manager; two computer specialists, one operator, and one scheduler. With the exception of the operator who is on swing shift, the rest of the staff is on prime shift.

There are two engineers on duty from 0600 - 1500 hours for the 205. There is an engineer on standby from 0000 - 0900 hours for all systems in the plant. Other hours are covered by 15 minutes on-call engineers. The aforementioned staff is adequate for good system reliability.

CCC

	One 8-Hour Shift	
	Used	Recommended
Supervisors	3	3
Programmers	5	5
Operators	1	1
Engineers	1	1

Operation tends toward closed shop.

Methods of training used includes two weeks schooling and on-the-job training.

CGC

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	3	3
Operators	1	1
Engineers	2	2

Methods of training used include programmer analyst-manufacturer's school and on-the-job training. Operators - on-the-job training and schools on peripheral equipment.

GE Rome, Ga.

	Two 8-Hour Shifts
Supervisors	3
Programmers	17
Coders	3
Clerks	1
Operators	2

Operation tends toward open shop.

Methods of training used include on-the-job training plus assignment of problems to programmers.

GICA

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	2	2
Analysts, Programmers & Coders	7	7
Operators	3	3
Engineers	3	3

One supervisor for Operations group and one supervisor for Programming group. Programmers combine functions of analysts, programmers and coders. Five programmers are adequate for 205 programming load - additional 2 used in researching new equipment, methods, etc.

ITT

	One 8-Hour Shift
Supervisors	2
Analysts	1
Programmers	5
Clerks	1
Engineers	1

Operation tends toward closed shop.

Training offered by computer manufacturer. Open courses in compiler programming. More recently we have trained our own programmers.

All programmers have degrees in Mathematics, Physics, Engineering, or Statistics. Open shop load is significant and is being encouraged.

KSC

	One 8-Hour Shift
Supervisors	1
Programmers	7
Operators	1

Operation tends toward closed shop.

Methods of training used include manufacturer's course followed by on-the-job training.

Linde

	One 8-Hour Shift
Supervisors	1
Analysts/Programmers	20
Coders	2
Clerks	1
Librarians	1
Engineers	1

Analysts and programmers consist of chemical, mechanical, electrical engineers and mathematicians.

A Burroughs maintenance engineer is assigned to the Linde installation. One operator is assigned to the second shift.

Coding instructions are given by Burroughs personnel and on-the-job training given by Linde's own senior personnel.

LA

	One 8-Hour Shift
Supervisors	2
Analysts	2
Programmers	2
Operators	2
Engineers	1

Methods of training used includes Burroughs schools, on-site training and on-the-job training.

MMLIC

	Three 8-Hour Shifts
Supervisors	3
Analysts, Programmers & Coders	3
Clerks, Librarians & Operators	4
Engineers	2
In-Output Oper	2

Operation tends toward closed shop.

Methods of training used includes manufacturer's courses and company held courses. Also on-the-job training.

NNG

	Two 8-Hour Shifts
Supervisors	2
Analysts	1
Programmers	10
Operators	4

NDCA

	Three 8-Hour Shifts	
	Used	Recommended
Sypervisors	1	1
Analysts	3	3
Programmers & Coders	4	4
Clerks	0	1
Operators	2	3
Engineers	1	1

Operation tends toward open shop.

Methods of training used includes on-the-job training. No formal lectures are given.

OOC

	One 8-Hour Shift
Supervisors	1
Programmers, Analysts, Coders, Librarians, & Operators	6
Engineers	2
Technicians	1

Operation tends toward open shop.

A comprehensive two-week course in programming and computer operation is offered annually (semi-annually when demand warrants) by the supervisor. The 2nd and 3rd 8-hour shifts run unattended.

PP & LC

	One 8-Hour Shift
Supervisors	1
Analysts	14
Technicians	2

Two operators are used on 2nd 8-hour shift.

Operation tends toward open shop.

Methods of training used includes course in programming and on-the-job training.

USS

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	4	5
Coders	1	2
Clerks	1	2
Operators	1	2
Engineers	1	1

Operation tends toward closed shop.

Methods of training used includes manufacturer's courses and on-the-job training.

WE System I and II

	Two 8-Hour Shifts
Supervisors	2
Analysts	6
Programmers	2
Clerks	2
Operators	4

These personnel apply to two (2) computer systems each operated for two 8-hour shifts.

Operation tends toward closed shop.

Programmers and coders are given 2-4 weeks programming school and operators are given 1 week programming school and on-the-job training.

WRL

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	3	3
Programmers	2	3
Coders	3	3
Clerks & Tape Handlers	1	1
Technicians	2	

The two technicians recommended for maintenance are needed only part time. It is necessary to have two, however, so that one man is always available.

Operation tends toward closed shop.

Method of training used is informal "courses" taught by experienced personnel.

U of N

The initial staff personnel is a Director, (half-time appointment; the other half of his time will be given to the Dept. of Mathematics where he will teach appropriate courses.) a maintenance engineer, a secretary-programmer, and two graduate assistants.

Operation tends toward open shop.

Methods of training used includes demonstrations, seminars, courses on computers and on numerical analysis.

U of D

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	1/2	1
Analysts/Programmers	3/4	4
Clerks	2	3
Technicians	1	1 1/2

Operation tends toward open shop.

Methods of training used include University courses given in Mathematic Dept., in-house by experienced personnel, and by Burroughs representatives.

U of V

Operation tends toward open shop.

Methods of training includes programming courses given by staff of center as the need arises.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

ABMA
Good time 18.8 Hours/Week (Average)
Attempted to run time 19.1 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.984

ABMA
Good time 31.5 Hours/Week (Average)
Attempted to run time 31.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 1.0

ABMA
Good time 34.5 Hours/Week (Average)
Attempted to run time 35.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.985
Above figures based on period 1 Jan 60 to 31 Mar 60

ABMA
Good time 34.1 Hours/Week (Average)
Attempted to run time 34.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.988
Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 1 Jan 59

ABMA
Good time 30.7 Hours/Week (Average)
Attempted to run time 31.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.99
Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 1 Sep 58

ARGMA
Good time 60 Hours/Week (Average)
Attempted to run time 63 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Sep 58 to May 60
Passed Customer Acceptance Test Jul 58
Time is available for rent to qualified outside organizations.

USA CC
Average error-free running period Two Weeks
Good time 47 Hours/Week (Average)
Attempted to run time 48 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period 1 Mar 60 to 31 Mar 60
Passed Customer Acceptance Test Jun 58
Time is not available for rent to outside organizations.

BNS
Good time 88.3 Hours/Week (Average)
Attempted to run time 93.6 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.943
Above figures based on period 1 Feb 60 to 31 Jul 60
Passed Customer Acceptance Test 15 Sep 58
Time is available for rent to qualified outside organizations.

A limited amount of engineering work is performed for other Naval activities. Time is not available to commercial organizations.

USN HO Washington
Good time 64 Hours/Week (Average)
Attempted to run time 78 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.82
Above figures based on period 1 Oct 59 to 31 Dec 59
Passed Customer Acceptance Test Jul 56
Time is not available for rent to outside organizations.

The down-time includes not only machine failure but down-time due to air conditioning, electrical power, etc.

USN MDL
Average error-free running period 6 Hour (Average)
Good time 86 Hours/Week (Average)
Attempted to run time 93 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.92
Above figures based on period 1 Apr 60 to 1 Aug 60
Passed Customer Acceptance Test Aug 57
Time is not available for rent to outside organizations.

USNOL Corona
Good time 126 Hours/Week (Average)
Attempted to run time 140 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 1 Jan 59 to 31 Dec 59
Passed Customer Acceptance Test 28 Mar 58
Time is not available for rent to outside organizations.

USN RDL
100, 105, 0.95, 1 Jan 60 to 30 Jun 60, 19 May 58, is not, respectively as above.

USN USL
77, 80, 0.9625, 1 Apr 58 to present time, 1 Apr 58, is not, respectively as above.

Griffiss AFB
39, 40, 0.975, 1 Apr 59 to 1 Apr 60, Jan 58, respectively as above.

NASA ARC
System 107 - 43.8, 46.7, 0.94, 1 Jan 59 to 31 Dec 59, Apr 55, is not; System 128 - 49.5, 52.5, 0.94, 1 Jan 59 to 31 Dec 59, Apr 56, is not.

About 15 percent of the total "on time" on System 107 and about 17 percent on System 128 is scheduled preventative maintenance.

ATIC W-P
100, 110, 0.91, Jul 58 to Mar 60, Jul 58, is not.

AIC
Three systems are operated on a two shift basis. They average 25% maintenance.

Little
42, 48, 0.875, Sep 59 to Mar 60, Feb 58, is available.

We have experienced good operation on the basic computer. Main difficulties occur on card input and output and magnetic tape. Tape systems at first were very unreliable, caused by weak read and write signals abd bad tape. Modifications of tape units in past year as well as introduction of sandwich mylar tape has greatly improved the reliability of tape system. Card input and output, because of inability to check input and output, are main areas of failure now.

B & W Alliance
32 hrs/week available, 1 hr/week unscheduled down time, 0.96, 11 Feb 60 to 1 Aug 60, 11 Feb 60, is.

B & W Lynchburg
50, 51.5, 0.97, Spring 56 to present, Apr 56, is not.

Burroughs
59, 60, 0.983, Jan 60 to Jul 60, Jun 56, is.

CCC
47.3, 49.5, 0.96, Aug 58 to Jul 60, 1 Feb 58, is available to qualified.

GE Rome, Ga.
78, 89, 0.876, Apr 60 to Aug 60, Nov 57, is not. Good time is total time less down time less any rerun time.

GICA
78, 86, 0.907, L Jan 60 to 18 Apr 60, Feb 56, is not. On occasion we have made computer available at no charge. In theory we have built up credit hours on another computer but have not used them.

ITT
30+, approx. 0.95, Feb 59 to Jun 60, Feb 59, is.

KSC
15 (Good time), 1 Jul 59 (Passed Customer Acceptance Test), is not.

Linde
60, 0.98, Dec 58 to present, 18 Dec 59, is not.

LA
Time is available. Experience in the past year has averaged about 90% availability. This is considerably

higher than the first two years.

MMLIC

137.5, 142, 0.968, 18 Aug 57 to 14 Aug 60, 18 Aug 57, is not.

NNG

66, 72, 0.92, 1 Jan 60 to 1 Aug 60, 17 May 57, is not.

NDCA

100, 120, 0.80, 1 Aug 59 to 1 Aug 60, Jul 56, is.

OOC

100, 102.7 0.974, Jan 59 to Jan 60, Jul 57, is not. The high reliability of our computer installation is attributed to the daily two hour preventive maintenance schedule maintained by our engineers.

PP & LC

93, 93, 1.0, 1 Apr 60 to 31 Jul 60, Spe 57, is not. Requirements averaged 93 hours of work to be done and it was done. We had an average of 3.7 hours lost time per week from all causes, including material trouble and accessory IBM machine troubles. Scheduled maintenance averaged 11.2 hours per week.

USS

36, 40, 0.90, 1 Jan 60 to 15 Apr 60, 22 Dec 59, is not.

WE System I

12, 71.0, 76.4, 0.93, 1 Jun 60 to 30 Jun 60, 1 Nov 58, is not.

WE System II

14, 67.4, 77.0, 0.88, 1 Jun 60 to 30 Jun 60, 1 Jan 59, is not.

WRL

40, 40+, 0.96, 1 Sep 56 to present, 1 Sep 56, is not.

U of D

4-5 months, 70, 70, 0.999, Jan 59 to Dec 59, 15 Jul 58, is available at $40.00 per hour.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

The automatic address-modification features of the B-register along with its automatic tally. Automatic editing provided by the format bands on Cardatron buffer drums, as well as freeing of the central computer as soon as information is transferred. This allows input, output, and processing simultaneously while card machines operate at a maximum rate. Independent search for permanently addressed blocks on magnetic tape, which allows processing of results of previous search while current search is going on. Ability to read from magnetic tape, update information, and write back on the same tape in the same position. Provision of high speed through quick-access loops, which allows straightforward sequential coding and does not require complicated placements of instructions or data for minimal access.

The Burroughs Card Input Unit, Model 293, with a reading rate of 300 cards per minute is now available for use with the Burroughs 205 Cardatron. Also available is the Burroughs Card Output Unit (Model 292), which operates at 100 cards per minute, either reading or punching, and the Burroughs Line Printer, Model 289, which operates at the rate of 150 lines per minute. Editing features of the Cardatron system are complemented by the use of this Cardatron Input/Output Equipment.

Required storage environment for magnetic tape includes temperature 60 degrees to 80 degrees; relative humidity 40% to 60%; magnetic fields, not to exceed three oersteds; radiation, where radiation is not dangerous to people; dust proof containers; reels placed in plastic containers and stored on edge of container in a vertical position; must be rewound on a 205 Tape Storage Unit. Minimum storage life, one year when stored as outlined above.

BNS

Unique system advantages include the Cardatron System and Magnetic Tape Bin File.

Tapes retained in computer room in plastic cases, numbered with 3x5" card index of usage and condition. Computer system is supplemented by 10,000 point EAM (IBM) installation, run on a two-shift basis.

USN HO Washington

The 205 is extensively buffered by the Cardatron system for both input and output. The 205 provides several input-output media, i.e. punched card, punched paper tape, magnetic tape (in & out) plus printed tabulations (out).

Duplicates of all data tapes are filed in a building other than the computer building; all data tapes (originals and duplicates) are stored in areas with temperature and humidity control.

USN MDL

Each magnetic tape reel is assigned a number. Card files are kept on these numbers, recording the entire history of each tape. Tapes are individually packages in hard plastic dust-free containers. Containers are stored in steel storage cabinets. Humidity and temperature are automatically controlled in accordance with the specifications set forth by the magnetic tape supplier.

USNOL Corona

Outstanding features include ease of programming in machine language.

Little

Outstanding features include programmed editing of card input and output and "on-line" printer without using different plugboards, and addressable magnetic tapes.

Tapes on precision reels, stored in plastic, air-tight containers in cabinets in computer room.

AMIC

Outstanding features include input, output buffering, and input, output editing.

Identifying code is put on tape, on box, in book and filed in same air control as computer in box.

B & W Lynchburg

Copies of important tapes are kept in fireproof vault. Working tapes are kept in computer room under standard condition of temperature and humidity.

Burroughs

Outstanding features include buffered search operation on fixed address and length records in the magnetic tape system. High speed memory loops for minimum latency. The use of a Datafile greatly enhances the use of an operating system. Excellent programming systems are available such as: Shell Assembler, FORTRANSIT Algebraic Compiler, and ALGOL 58 Algebraic Compiler.

GE Rome, Ga.

Reels of tape numbered and assigned by number and card indexed. Storage in Remington Rand Tape Cabinets. Humidity control 20% - 60%. Duplicate records maintained in another building.

GICA

Store critical tapes in fire resistant vault. All other tapes stored in plastic reel cans in temperature and humidity controlled room.

MMLIC

Outstanding features include input and output buffer with program edit feature and large random access.

Inserts (labels) in reel containers, controlled temperature and humidity, and storage of master reels in other than computer room.

NNG

Outstanding features include the flexibility of the Cardatron.

For storage of magnetic tape, temperature and humidity control, Avery adhesive labels for magnetic tape reels are used, and Records Reserve Corp. storage plastic containers for tape.

OOC

Outstanding features include high speed storage or quick access loop storage, addressable magnetic tape, and simplicity of programming due to B-register tallying and address modification, automatic sequencing control counter, programmed breakpoint, etc.

Handling of magnetic tape. Reels of magnetic tape (250 ft or 2500 ft) are assigned to research personnel having a need for same. They are used only by the individual to whom assignment has been made. All reels of magnetic tape are stored in the temperature and humidity controlled computer room from which they are never removed. Tape labelling is left to the discretion of each individual.

WE System I

Outstanding features include a large tape storage capacity (permanent - "Datafiles") - 6,000,000 words, large drum storage capacity - 4,080 words, IBM Code - Burroughs code conversion and format editing devices, independent magnetic tape search, and photo electric reader, for program entry (540 digits per second).

Magnetic tape handling: all tapes and duplicates stored in metal cabinets in same room as computer (72°F - relative humidity 45%). Tape labeling variable, depending on job. Usually a revolving numbering system with job title identification. External labeling shows job title and reel number.

FUTURE PLANS

ARGMA

A second Burroughs 205 with same exact configuration is scheduled for installation in the OML Division, Army Rocket & Guided Missile Agency, Redstone Arsenal, Alabama.

USA CC

It is anticipated that a new computer will be installed in the near future. Selection of new computer has not been established at this time.

BNS

Approval for installation of one IBM Type 1401 Data Processing System (no tapes) has been requested from the Bureau of Ships. Upon installation of this system in June/July 1961, sizeable reductions in data processing costs will be effected and the system will be utilized to augment existing equipment on an interim bais pending completion of necessary studies to justify a new transistorized, core storage, central shipyard computer (the feasibility study for this system was submitted to BuShips on 21 July 1960).

New major applications under consideration for application to the 1401 and subsequently to the new centralized computer include total supply inventory, cost accounting, and production planning and control.

Ultimate goal of data processing personnel is the development of a shipyard-wide, fully integrated data processing system in which source data automation techniques will be exploited to the maximum possible extent, and the master file so designed that common data will be reused where possible to effect desired reports in the shortest possible time and in the most economical manner.

USN HO Washington

It is planned to replace the present 205 with a higher speed computer.

USN MDL

Future plans call for purchase of IBM 704 System to replace our present system. This replacement will greatly increase our productivity and make available more time for new applications.

USNOL Corona

Plan to replace the present computer system with an IBM 7070 System.

USN USL

Consideration for the purchase of IBM 704 System, configuration to be Core Memory 8K, Drum Memory 8K, Magnetic Tape Units 4, Card Reader, Card Punch, On-line Printer, Paper Tape Input and Off-line Magnetic Tape to Printer.

NASA ARC

At the present time a building is being designed for the Ames Research Center, primarily for housing computing equipment and the associated staff.

This new facility should be occupied during the first half of 1961. At this time a medium size Honeywell 800 System will be leased to take over all functions of the Burroughs equipment and perform additional scientific calculations.

ATIC W-P

System to be replaced by an IBM 7090.

B & W Lynchburg

There is some talk of doing on line experimental data reduction either with another smaller machine or by creating a data link to connect the laboratory devices to the computer (12 miles distant). A larger machine capable of doing two dimensional nuclear codes would be considered if the work load justified it.

Burroughs

Replacement of present card input-output equipment with Burroughs equipment.

Burroughs Model 289 Line Printer	150 lines/min
Burroughs Model 292 Output Unit	100 cards/min
Burroughs Model 293 Input Unit	300 cards/min

CCC

Add automatic floating point and magnetic tape (Datafile) in the immediate future.

GICA

Delivery schedule for the next two years is as follows:

May 1960	305 RAMAC
May 1961	1401 - 4 tapes
Nov 1961	1401 - 4 tapes
Dec 1961	7070 - 8 tapes
Feb 1962	1401 - 4 tapes

Plans have not been finalized with respect to the balance of the applications among the equipment. There are no definite plans for retiring our Burroughs 205.

KSC

Replace with Univac Solid State 80. Add hourly payroll processing for 7,000 employees.

LA

We are currently conducting a feasability study of the new family of medium scale computers in the microsecond range. We have narrowed the field down to IBM, RCA and NCR in the medium price range. This study was started because we need a faster computer for our current work load, magnetic tape for future applications, and the economy of the new series of computers.

NNG

Feasibility study to determine more computer power in progress.

PP & LC

Within next several years, increased requirements may be greater than present computer capacity. When need for more capacity is foreseen, an additional or a more powerful computer will be ordered as found most feasible at that time.

USS

Probable acquisition of Cardatron for punched card input/output within a year.

Probable acquisition of larger computing system within three to five years.

WE System I

No new applications are planned for this system as the full two shift capacity has been reached. All programming and planning effort is being expended on a new IBM 7070/1401 Tape System due for installation August 1961. At this time all jobs will be cut over in their present form. After cutover, new applications and amplification of present systems can be undertaken, because of the greater speed and capacity of this new system.

U of N

It is expected that in the near future the following items of hardware will be added to the initial equipment:

a floating point device, magnetic tape and a Cardatron.

U of D

A Model 500 Punched Card Converter, IBM 523 Summary Punch, and IBM 514 Reproducing Punch is to be added.

INSTALLATIONS

U. S. Army Ballistic Missile Agency (5)
Computation Laboratory
Redstone Arsenal, Alabama

Army Rocket & Guided Missile Agency
Redstone Arsenal, Alabama

U. S. Army Chemical Warfare Laboratories
U. S. Army Chemical Center, Maryland

Boston Naval Shipyard
Boston 29, Massachusetts

U. S. Navy Hydrographic Office
Washington 25, D. C.

U. S. Navy Mine Defense Laboratory
Panama City, Florida

U. S. Naval Ordnance Laboratory
Corona, California

U. S. Naval Radiological Defense Laboratory
San Francisco 24, California

U. S. Navy Underwater Sound Laboratory
New London, Connecticut

Hq, R.A.D.C.
Griffiss Air Force Base, New York
ATTN: RCCS

Ames Research Center, NASA
Moffett Field, California

Aerospace Technical Intelligence Center
Wright-Patterson Air Force Base, Ohio

Allstate Insurance Company
Menlo Park, California
Sacramento, California
Atlanta, Georgia

Arthur D. Little, Inc.
35 Acorn Park
Cambridge 40, Massachusetts

Atlantic Mutual Insurance Company
45 Wall Street
New York 5, New York

Babcock & Wilcox Research Center
Alliance, Ohio

Babcock & Wilcox Company
1201 Kemper Street
Lynchburg, Virginia

Burroughs Corporation, Computer Facility
460 Sierra Madre Villa
Pasadena, California

Celanese Chemical Company
520 Lawrence Street, P.O. Box 561
Corpus Christi, Texas

Citizens Gas & Coke Utility
2020 N. Meridian Street
Indianapolis, Indiana

General Electric
Redmond Circle
Rome, Georgia

General Insurance Company of America
4347 Brooklyn
Seattle 5, Washington

International Telephone & Telegraph Laboratories
500 Washington Avenue
Nutley, New Jersey

Kaiser Steel Corporation, Box 217
Fontana, California

Linde Company, Box 44
Division of Union Carbide Corporation
Tonawanda, New York

Louis Allis Company
427 E. Stewart Street
Milwaukee, Wisconsin

Minnesota Mutual Life Insurance Company
345 Cedar
St. Paul 1, Minnesota

Northern Natural Gas Company
2223 Dodge Street
Omaha, Nebraska

Nuclear Development Corporation of America
5 New Street
White Plains, New York

The Ohio Oil Company, P. O. Box 269
Littleton, Colorado

Pacific Power & Light Company
920 S. W. Sixth Avenue
Portland 4, Oregon

United States Steel Corporation
Monroeville, Pennsylvania

Western Electric Company, Inc. Dept. 312 (2)
1600 Osgood Street
North Andover, Massachusetts

Westinghouse Research Laboratory
Pittsburgh 35, Pennsylvania

University of Nebraska
Lincoln, Nebraska

University of Denver
Denver 10, Colorado

University of Virginia
McCormick Road
Charlottesville, Virginia

Behr-Manning Corporation
P. O. Box 896
Troy, New York

BURROUGHS 220

MANUFACTURER

Burroughs 220 Electronic Data Processing System

Burroughs Corporation

Photo by the Burroughs Corporation

APPLICATIONS

Manufacturer
The Burroughs 220 is a general-purpose, stored-program, sequentially-controlled, series-parallel, automatic, electronic, data processing system which employs a single-address code, and is equally adaptable for either scientific or data processing applications.

U. S. A. Signal Research & Development Laboratory
Located in Room 1B334, U.S. Army Signal Research & Development Laboratory, the system is used as a computational tool in solution of scientific and technical data processing problems which are submitted to computation center by USASRDL engineers and scientists.

U.S. Navy Long Beach Naval Shipyard
Located at the Data Processing Office, Long Beach Naval Shipyard, Long Beach 2, Calif., the system is used for payroll, bond and leave, financial accounting, inventory and supply, production, planning and control, public works transportation and controlled maintenance programs, personnel accounting, scientific and engineering, and tool control.

USAF Aeronautical Chart and Information Center
Located at the Data Processing Division, Office of the Comptroller, 2nd and Arsenal Streets, St. Louis, Mo., the system is used for civilian payroll, manhour and cost accounting, chart inventory, and technical computations.

USAF DCS/Comptroller, Air Training Command
Located at Randolph Air Force Base, Texas, the system is used for personnel accounting. The master records for all assigned personnel, officer, airmen and civilian, are maintained on magnetic tape. Each group is updated with current data transceived from the bases on a daily basis. Summary reports are prepared from these tape files. These month-end summary reports are for USAF as well as local use. The preparation of the summary reports at this level has relieved the bases of this task. Inquiry service (the capability to make personnel selections from the master files based upon certain criteria) is available to DCS/Personnel. System is also used for personnel

Photo by the Long Beach Naval Shipyard

authorization. The authorized strength of the entire command is maintained (by unit) on magnetic tape. This file is periodically updated with changes received from the Headquarter's Manpower Office. Various reports, including the Unit Manning Documents, are prepared from this file. The many bases of the Command are no longer responsible for the maintenance of the file and preparation of summary authorization reports. In addition, system is used for military personnel manning statistics. Programs are almost completed which will provide DCS/Personnel with up-to-date manning statistics for officers and airmen. The authorized and assigned files will be combined into one tape file with the major control on AFSC. Summary reports as well as inquiry service will be available from this manning file.

Headquarters, Tactical Air Command

Located at the Systems Division, Directorate of Statistical Services, Deputy for Comptroller, Headquarters Tactical Air Command, Langley AFB, Virginia, the system is used for:

Personnel Accounting (Officer, Airmen, and Civilian)

Master File Composition. Centralized master tape records of all officers, airmen, and civilians assigned to TAC. Record Content. Initially: For officers, all items of data in the 901 and Repository Files; for airmen, all items in the 900, OJT and Overseas Volunteer Files; for civilians, all items in the SS800 File. Subsequently: Additional items as required for effective command management of the personnel resources. File Maintenance. Master records updated from personnel data changes furnished directly from the base. Initially, the base will mail changes six times a month. Subsequently, the base wil will transceive changes more frequently (possibly daily). Service to Management. Initially: (1) Summary reports for the local staff and Headquarters, USAF, (2) Complete files "fed-back" to the subcommand headquarters for their local use. Subsequently: (1) Tape interrogation concerning local management queries, and (2) Summary reports "fed-back" to the subcommands.

Stock Number Control

Master File Composition. Centralized master tape records of all stock numbers required to monitor the TAC UAL system and such other related applications as the ECLs (Equipment Component Lists). Also, records cross-referencing stock number conversions, changes, consolidations, etc. Record Content. All items of data required in the UAL document by AFM 67-1. File Maintenance. Master records updated from changes furnished by TAC supply on a semi-monthly basis. Service to Management. (1) A quarterly TAC catalog of selected stock number data furnished to

Photo by the USAF Aeronautical Chart & Information Center

the TAC equipment managers. "Add and Delete" type changes required for catalog maintenance will be furnished during the quarter. (2) Accurate UAL records achieved by screening all UAL changes through the Master Stock Number Control Tape.

Manpower and Organization System Management

Master File Composition. Centralized master tape records reflecting the UMD distribution of all manpower authorizations alloted to TAC. Record Content. Initially, all items of data required by the 2-AF-03 File and the AF-05 Report. Subsequently, additional items as required by the local staff. File Maintenance. Master records updated from changes furnished by the Headquarters TAC Manpower Activity. Initially, updating will be semi-monthly; subsequently, a study will be made to determine the need of more frequent updating. Service to Management. Initially: (1) Summary reports for the local staff and Headquarters USAF, (2) complete punched card files furnished the filed each quarter; punched card "Add and Delete" changes furnished during the quarter. Subsequently: Tape interrogation concerning management queries.

Organization Equipment Management System

Master File Composition. Centralized master tape records of all items of equipment in the TAC UAL system. Record Content. Initially: All items of data required by AFM 67-1, plus certain TAC management codes. Subsequently: Additional items as required by the local managers. File Maintenance. Master records updated from authorization changes furnished by TAC supply, and from in-use changes furnished by the base. Initially, updating will be monthly; subsequently, updating will be more frequent (actual frequency to be determined later). Service to Management. Initially: (1) Periodic CAL (Command Authorization List) to TAC supply managers, (2) summary reports for Headquarters USAF, AMC, and TAC, (3) "Add and Delete" punched card changes to field managers for the maintenance of base and unit UAL decks. Subsequently: Tape interrogation concerning management queries.

Financial

Data developed in this functional area will be based primarily on requirements established by Headquarters TAC. Management information based on shred-out data obtained from the 1 and 2-AF-C86 Reports and C-100 Expense Reports by procurement source and regulated codes is under consideration. Expansion into the fields of procurement and budget, monetary inventory of UME/USE equipment, weapon-system monetary statistics etc., will be included as required.

Intelligence Data Processing and Analysis

Summary of Application: Compilation of target lists from catalogs, and listings of these in a multiplicity of factirs bearing on target analysis. Order-of Battle information will be prepared as desired.

Operations Analysis Problems

Summary of Application. Operations analysis problems will be processed on an "as required" basis. Requirements will probably be in the area of iterative computations, interpolation, data reduction, trial

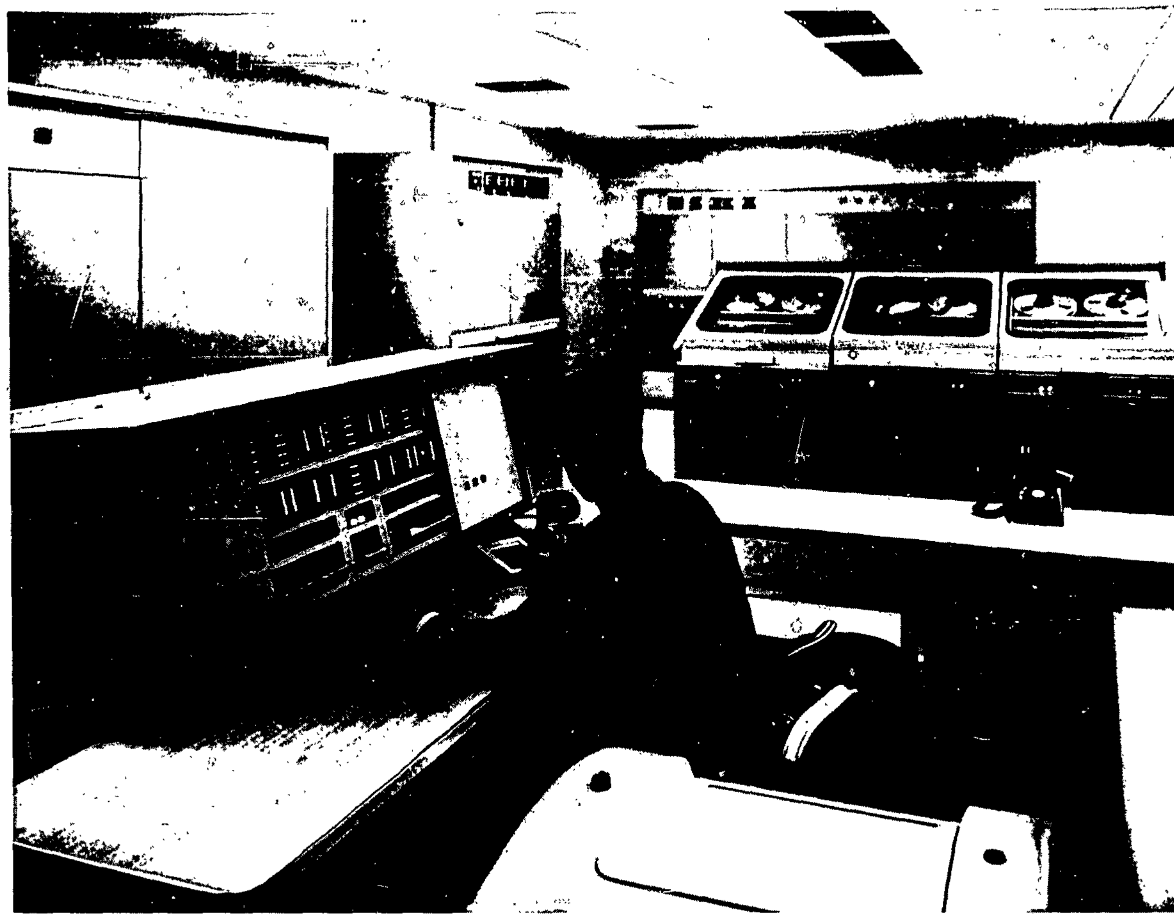


Photo by the Dow Chemical Company

and error solutions and matrix inversion.

U. S. Geological Survey

Located at the Dept. of Interior, 18th and C Streets, N. W. Washington, D. C. - Room 1461, the system is used for scientific computations in such fields as crystallography, water resources topography, and geophysics. System is also used for data processing such as payroll, leave, personnel statistics, accounting and labor distribution.

Abbott Laboratories

Payroll: incentive calculation, gross to net, special personnel statistics; accounts receivable: open file method, cash application statement preparation; finished goods inventory: maintain current branch and combined balances, project gross and net requirements monthly and quarterly, calculate economic shipment amount to branches, analyze book balances to physical counts; work in process inventory: process requisitions, deliveries to stock, calculate progressive biweekly balances; customer statistics: accumulate monthly, quarterly and year to date gross and net sales for all customers, provide monthly, quarterly and yearly sales statistics for certain product groups by customer geographic location, class of customer; salesmen statistics: accumulate monthly product group sales for each salesman, calculate salesman's compensation, provide quarterly sales statistics for salesman, district division, area, etc.; sales department statistics: provide upon demand product sales figures for market research, advertising, new product sales; and production planning: project gross production requirements, explode to raw materials requirements, and compare stock levels against projection.

Allstate Insurance Company

Systems, located at the Allstate Regional Offices in Pasadena, Illinois, Detroit, Murray Hill (NJ) and Harrison (NY), are used for policy issuance and accounting relative to the policy holder.

Babcock & Wilcox Company

Located on Van Buren Avenue, Barberton, Ohio, the system is used for heat transfer, fluid flow, and estimating programs utilized for design of high pressure, high temperature steam generators, stress analysis and vessel design for nuclear equipment, shop scheduling, and production of work sequence sheets for tube bending.

Burroughs Research Center

Located at Paoli, Pennsylvania, the system is used for payroll, labor distribution, missile flight simulation, logic simulation, linear programs, and battery target assignment.

Photo by Smith, Kline and French Laboratories

Burroughs Corporation, Computer Facility
Located at 460 Sierra Madre Villa, Pasadena, California, the system is used for debugging of programs for Burroughs' customers, corporate data processing, and block time rentals to the public.

The Dow Chemical Company
Located in the 687 Bldg., Dow Chemical Company, Midland, Michigan, the system is used for statistics and design of experiments, operations research and linear programming (production scheduling, blending, transportation), chemical engineering (dist., heat transfer, mass transfer, kinetics, design, etc.), thermochemical (thermodynamic properties, fuel evaluation, etc.), physical chemistry (Urey-Bradley Force Fields, spectroscopy, etc.), Polymer chemistry, and general research problems in a variety of the sciences.

Hoffman Military Products Division
Located at 959 South Flower, Los Angeles, California, the system's primary use is as part of AN/ULD-1 Reconnaissance System, processing data of a classified nature. Also being used in mission simulation studies, antenna calibration and Table 202A data processing for same system. System is being made available for running of problems on other government contracts with rental credit reverting to AN/ULD-1 contract.

Smith, Kline & French Laboratories
Located at 1500 Spring Garden Street, Philadelphia 1, Pennsylvania, the system is used for selection and listing of doctors' names from a continuously corrected master file (magnetic tape) for mailing or survey applications. The information required consists of name, address, city, state and other coded material such as age, medical specialty, etc., as well as for statistical manipulation of clinical data for medical research and development.

Stanford Research Institute
Located in Building 410B, Stanford Research Institute, the system is used for business data processing (payroll, labor extension, etc.), and scientific calculations.

The Upjohn Company
Located at Upjohn Company, Kalamazoo, Michigan, the system is used for sales analysis, finished goods inventory control, production planning and scheduling.

California Institute of Technology
Located at 1201 East California Street, Pasadena, the machine is used for research in the areas of Astrophysics, Biology, Chemistry, Physics, Applied Physics and Engineering, Mathematical and Numerical Analysis.

Cornell University
Located in Rand Hall, Cornell University, Ithaca, N.Y.,

Photo by the Upjohn Company

the system is used for teaching and research in scientific computation and data processing for Engineering, Physical Sciences, Agriculture and Business.

Georgia Institute of Technology

Located at the Rich Electronic Computer Center, Georgia Institute of Technology, Atlanta 13, Ga., the system is used for education and research in all fields of engineering and science. Center provides research assistance to commercial and industrial sponsors.

John Deere Waterloo Tractor Works

Located at 400 Miles Street, Waterloo, Iowa, the system is used for inventory control and analysis, production and purchasing control, product costing, and machine capacity.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal
Decimal digits/word	10 + sign
Decimal digits/instruction	2 - 10
Instructions/word	1
Instructions decoded	93
Arithmetic system	Fixed and floating point
Instruction type	One address

Number range Fixed point $-1 < N < +1$

Floating point $10^{-51} < N < 10^{+49}$

S	1 4	5 6	7 0
±	Control Digits	Oper Code	Address

Star 1, Star 2, Star 2A, assembly routines and Burroughs Algebraic Compiler routines are available.

In the control and arithmetic sections of the computer are seven electronic display registers. The B register of the 220, is used for automatic modification of instructions, and may be counted either up or down by any amount.

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	200	185
Mult	2,070 avg.	2,055
Div	3,985 avg.	3,970

Construction (Arithmetic unit only)

Vacuum tubes approx. 1,800 in central processor

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Photo by Georgia Institute of Technology

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	10,000	110,000	15
Magnetic Tape Reel	1,367,200	15,039,200	250
Datafile	4,880,000	53,680,000	16,000 avg

Magnetic Tape

No. of units that can be connected	10	Units
No. of char/linear inch	416.33	Char/inch
Channels or tracks on the tape	12	Tracks/tape
Blank tape separating each record	0.26	Inches
Tape speed	120	Inches/sec
Transfer rate	25,000	Char/sec
Start time	5	Millisec
Stop time	5	Millisec
Average time for experienced operator to change reel of tape	90	Seconds
Physical properties of tape		
Width	0.75	Inches
Length of reel	3,500	Feet
Composition	Mylar	

USA-SRDL

4,000 words of magnetic core storage and 4 magnetic tape units.

USN LBNS

10,000 words of magnetic core and 10 magnetic tape units.

USAF ACIC

5,000 words of magnetic core and magnetic tape.

USAF DCS/C ATC

10,000 words of magneti core, 5 magnetic drums of 29 words each,. and magnetic tape.

TAC

5,000 words of magnetic core. In addition, each Burroughs Magnetic-Tape Storage Unit stores information on reels containing up to 3,500 feet of tape with a maximum capacity of approximately 1,400,000 words. The TAC EDP System consists of 5 units (1,400,000 x 5 = 7,000,000).

USGS

10,000 words og magnetic core and magnetic tape.

Abbott

5,000 words of magnetic core and magnetic tape.

AIC

Each system (5) has 5,000 words of magnetic core and six magnetic tape units.

B & W

8,000 words of magnetic core.

BRC

10,000 words of magnetic core and magnetic tape.

BCCF
System has 10,000 words of magnetic core. Magnetic tape reels are 3,500 feet. Two lanes of information. Datafile is 50 tapes in parallel, each 250 feet. Blocks are variable length-from 10 to 100 words per block. All magnetic tape is moved at rate of 25,000 digits per second. System has 9 tape units and 1 Datafile.

Dow
5,000 words of magnetic core and 3 tape units.

Hoffman
5,000 words of magnetic core and 5 magnetic tape units.

SKFL
5,000 words of magnetic core and 8 magnetic tape units.

SRI
5,000 words of magnetic core and magnetic tape.

Upjohn
10,000 words of magnetic core.

Cal Tech
5,000 words of magnetic core and 2 magnetic tape units.

Cornell
5,000 words of magnetic core and 4 magnetic tape units.

Georgia Tech
5,000 words of magnetic core and 4 magnetic tape units. 440 microseconds of magnetic tape access time is based on reading speed of 25,000 chars/sec. It does not include time to search for desired information and begin reading.

INPUT

Manufacturer

Media	Speed
Paper Tape	1,000 char/sec
Keyboard	Manual
Magnetic Tape	25,000 char/sec
Cards	400 char/sec

Up to ten photo-electric paper tape readers may be included in a system. Card reader speed is per card reader. Up to seven printers and/or punches and/or readers in any combination may be used per system.

USA-SRDL
Magnetic tape, paper tape, cards and keyboard.

USN LBNS
Magnetic tape, paper tape, cards and keyboard.

USAF ACIC
Punch card input through use of IBM 087 Collator. Card and PPT input buffered through cardatron system. Magnetic tape.

USAF DCS/C ATC
Magnetic tape, paper tape, cards (087 Collator) and keyboard.

TAC
The IBM 089 does not input directly into the Data Processor. The Burroughs EDPS uses a buffering device called a "Cardatron". Input media are also magnetic tape, paper tape and keyboard.

USGS
Magnetic t e, paper tape, and IBM 089 cards.

Abbott
Cards, paper tape, and magnetic tape.

AIC
Magnetic tape and cards.

B & W
IBM 089 cards.

BRC
Magnetic tape, paper tape, and cards.

BCCF
Magnetic tape, paper tape, cards and keyboard.

Dow
Magnetic tape, paper tape, IBM 087 cards and keyboard.

Hoffman
Magnetic tape, paper tape, cards and keyboard.

SKFL
Magnetic tape, paper tape, and cards (Cardatron).

SRI
Magnetic tape, paper tape, and cards.

Upjohn
Two IBM 087 cards.

Cal Tech
Paper tape.

Cornell
Magnetic tape, paper tape, and IBM 087 cards.

Georgia Tech
Magnetic tape, paper tape, and cards. Paper tape reader will stop on a character and is program controlled.

Deere
Paper tape and IBM 087 cards.

OUTPUT

Manufacturer

Media	Speed
Supervisory Printer	10 char/sec
Paper Tape	60 char/sec
Magnetic Tape	25,000 char/sec
Cards	1,800 char/ min

Up to seven printers and/or punches in any combination may be used per system. High speed printer may be used either on-line or off-line with a maximum speed of 1,500 lines per minute. As many as ten paper-tape punches may be included per system. Card speed is per card punch.

USA-SRDL
Magnetic tape, paper tape, IBM 407 Tab, cards, and supervisory printer.

USN LBNS
2 IBM Model 407 Printers to be released upon the final acceptance of the Hi-Speed Printer. Cards and magnetic tape are also output media.

USAF ACIC
Card output through use of IBM 523 Summary Punch; printed output through use of IBM 407 Accounting Machines; card, paper tape and print output buffered through Cardatron System.

USAF DCS/C ATC
Magnetic tape, paper tape, 2 IBM 407 Tabs, 2 IBM 523 Cards, and supervisory print-out.

TAC
1 IBM 407 Printer, 1 IBM 514 Card Punch, Magnetic Tape, and Supervisory Printer. Cardatron buffer also used for output.

USGS
IBM Cards, IBM 407 Printer, Magnetic Tape, and Supervisory Printer.

Abbott
Cards, IBM 407 Printer, and supervisory printer.

AIC
Magnetic tape, cards, and printers.

B & W
Cards and IBM 407 Printer.

BRC
Paper tape, punched cards, magnetic tape, and printer.

BCCF
High speed paper tape punch, card punch, printer, high speed printer, and supervisory printer. The high speed printer can be used off or on line. During off-line operations, one or two magnetic tape storage units are used.

Dow
Magnetic tape, paper tape, IBM 407 Printer, IBM 523 Cards and supervisory printer.

Hoffman

Magnetic tape, paper tape, IBM 407 Printer, IBM 521 Cards.

SKFL

Cardatron Punch (IBM 523), Cardatron Printer (IBM 407), magnetic tape, paper tape, supervisory printer, and high speed printer (Model 272).

SRI

Paper tape, IBM 523 Cards, IBM 407 Line Printer, and Teletypewriter. Magnetic tape also qualifies as an output medium (same speeds). It cannot be used off line in our system.

Upjohn

Burroughs high speed printer.

Cal Tech

Teleprinter and paper tape. A high speed line printer (300-500 lines/min) will be added early in 1961.

Cornell

Magnetic tape, IBM 407 Printer, IBM 523 Cards, and paper tape.

Georgia Tech

Supervisory printer, paper tape, punched cards, line printer (IBM 407), and magnetic tape.

Deere

2 IBM 407 Printers and 1 IBM 523 Punch.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Approximately 1,800 vacuum tubes are used in the central processor. Some 88,000 to 440,000 magnetic cores are used in the system.

CHECKING FEATURES

Manufacturer

The occurrence, for any reason, in the low order position of certain of the control registers of a configuration corresponding to any one of the decimal numbers from 10 to 15 is detected automatically.

A program check indicator will be turned on when such conditions as forbidden order code, improper partial word field or Branch on Compare when no comparison has been made.

Automatically halt computer operation when a non-existent address is specified by an instruction.

Automatic detection of an overflow condition during the execution of instructions which turns on the Overflow Indicator. Complete program control of the data processor's response to an overflow condition is standard on the Burroughs 220.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Model	Manufacturer Name	Kw	Weight	BTU	Inches Width	L	H
220	Data Processor	12.0	2800	41,000	158	29	76
380	Memory Control	4.5	1000	14,200	52.5	29	76
381-1	Core Stor Unit (2000-5000)	6.7	1200	22,800	79	29	76
400-4001	Power Ctl & Supply	10.0	2300	34,000	92	29	76
415	Control Console	0.1	500	340	59	35	49
465	Supervi Printer	0.6	250	2,040	23.5	22.75	39
440	Photoreader	0.7	175	2,380	23.5	22.75	47
470	High Speed Punch	0.3	175	850	23.5	22.75	47
510							
511	Cardatron Ctl U.	3.7	1700	12,600	80	29	76
512	Cardatron Input	2.8	850	9,500	40	29	76
513	Cardatron Output	2.9	850	9,800	40	29	76
550	Magnetic Tape Ctl	5.5	1000	18,700	53.5	29	76
551	Mag. Tape Stor.	4.0	1000	13,600	28	35	55
552	Datafile	1.5	1500	5,100	87	35	59
271	High Speed Printer Control	5.6	2000	16,000	33	60	76

The temperature and humidity must be maintained within the following limits: temperature range: 60 to 80 degrees Fahrenheit; relative humidity range: 40 to 60 per cent.

Amount of air conditioning depends upon size of computer system installed. For every 12,000 BTU/hr. generated by the system one ton of refrigeration is recommended.

USA-SRDL

Power, computer	49.4 Kw	55.5 KVA	0.87 pf
Plus 21 Kw D.C.			
Area, computer		210 sq ft	
Room size, computer		1,500 sq ft	
Room size, air conditioner		225 sq ft	
Floor loading		180 lbs/sq ft	
		700 lbs concen max	
Capacity, air conditioner		40 Tons	
Weight, computer		21,795	

Raised floor (plywood on 2"x8"'s) for all connecting cables.

USN LBNS

Power, computer	275 Kw	307 KVA	0.90 pf
Power, air condi	93 Kw	102 KVA	0.90 pf
Volume, computer		1,714 cu ft	
Volume, air conditioner (3)		54 cu ft ea.	
Area, computer		321 sq ft	
Area, air conditioner		18 sq ft ea.	
Room size, computer		60 ft x 60 ft	
Room size, air conditioner		20 ft x 20 ft	
		10 ft x 10 ft	
Capacity, air conditioner		70 Tons (Total)	
Weight, computer		32,420 lbs	
Weight, air conditioner		2,800 lbs, 3 Units	

The Shipyard ADP site incorporates the total facility for the centralized-data processing function, EDP, EAM, Key Punching and Programming.

The computer facility has been established in a concrete warehouse type building occupied jointly with the Supply Department and Comptroller Department.

The computer room occupies an area 60 ft x 60 ft.

Light-weight concrete approximately 12" high composes the outside perimeter of the plenum floor (40 ft x 40 ft). Floor covering is comprised of 2 ft x 4 ft of honeycombed aluminum sections.

The site is singularly designed to incorporate the latest air conditioning and fire-proofing requirements of the Bureau of Yards and Docks and District Public Works Office Eleven.

Three individual air conditioning units are installed to supply air conditioning from the floor to each individual equipment unit. The air plenum received conditioned air from two sources, 2 twenty ton units providing air from one side and 1 thirty ton unit from the opposite side of the raised floor.

CO_2 nozzles are installed under and into each equipment unit. Each nozzle is individually controlled, with a master valve to avert any accidental direction of the CO_2 into one or more units of the computing equipment.

USAF ACIC

Power, computer	5.20 Kw	8.30 KVA	
Power, air condition	40 Kw	34 KVA	0.85 pf
Volume, computer		202 cu ft	
Volume, chiller & pumps		1,200 cu ft	
Volume, Air Handling Units		5,000 cu ft	
Area, computer		32 sq ft	
Area, chiller & pumps		171 sq ft	
Area, Air Handling Units		624 sq ft	

Room size, computer	800 sq ft
Room size, chiller & pumps	9 ft x 19 ft
Room size, Air Handling Units	24 ft x 26 ft
Capacity, air conditioner	38 Tons
Weight, computer	3,200 lbs

Data processing equipment room approximately 2,300 sq ft, 20,000 cu ft was provided in one-story section of 130 year old warehouse frame and limestone construction, concrete floor slab on the ground. Modification included acoustical insulated ceiling, plastered walls, power wiring, which included ducts in floor for interconnecting wiring of units, new electrical sub-station 225 KVA and 440 volts and 150 KVA at 110 volts. Approximately 75% of the 225 KVA is directly and indirectly for the computer. Construction of housing for 75 HP, 400 cycle converter for computer equipment; 38 tons of air conditioning were provided by a central plant chiller of 65 tons capacity. Chiller, air handling units, exhaust system, humidifier, hot water heating system, cooling tower, 20 HP air compressor and 75 HP motor generator were located outside the computer area.

USAF DCS/C ATC

Power, computer	67 Kw	83 KVA	0.82 pf
Power, air condi	55 Kw	60 KVA	0.91 pf
Volume, computer		1,560 cu ft	
Volume, air conditioner		4,000 cu ft	
Area, computer		295 sq ft	
Area, air conditioner		480 sq ft	
Room size, computer		2,489 sq ft	
Room size, air conditioner		480 sq ft	
Floor loading		180 lbs/sq ft	
		130 lbs concen max	
Capacity, air conditioner		40 Tons	
Weight, computer		19,420 lbs	
Weight, air conditioner		20,000 lbs	

One thousand three hundred (1,300) square feet of the existing building was modified and one thousand one hundred and eighty-nine (1,189) square feet were added. False flooring was installed throughout the entire area. A separate power supply was installed for the EDP installation. Thirty-six (36) tons of effective air conditioning was installed outside of the modified area and is used for the EDP installation only.

TAC

Power, computer	73.43 Kw	57.97 KVA
Volume, computer		3,800 cu ft
Volume, air conditioner		706 cu ft
Area, computer		760 sq ft
Area, air conditioner		122 sq ft
Room size, computer		33 ft x 39 ft
Room size, air conditioner		20 ft x 26 ft
Capacity, air conditioner		75 Tons
Weight, computer		56,525 lbs

The conditioner services rooms other than the computer room. Conditioner footage includes two power transformers. Added a room for the air conditioner, power transformers and boilers, and installed same; installed air conditioning ducts, false ceiling, and "free Access" raised floor; insulated walls; increased transformer capacity. 247,500 BTU must be dissipated.

USGS

Power, computer	34.17 Kw	41.48 KVA	0.82 pf
Volume, computer		233,396 cu ft	
Area, computer		1,439 sq ft	
Area, air conditioner		378 sq ft	
Room size, computer		199.52 sq ft	
Room size, air conditioner		300 sq ft	
Floor loading		175-200 lbs/sq ft	
		250 lbs concen max	
Capacity, compressor		20 Tons	
Capacity, cooling tower		25 Tons	
Weight, computer		14,135 lbs	

Partial acoustical ceiling raised floor, additional air-conditioning and humidity control, and additional wiring from main building power supply.

Abbott

Power, computer	47.38 Kw	53.38 KVA	0.89 pf
240,250 BTU/hr.			
Power, air condi	35.2 Kw	41.5 KVA	0.85 pf
Area, computer		1,250 sq ft	
Area, air conditioner		240 sq ft	
Room size		40 ft x 40 ft	
Floor loading		200 lbs/sq ft	
		3,286 lbs concen max	
Capacity, air conditioner		30 Tons required	
		40 Tons expansion	
Weight, computer		16,195 lbs	
Weight, air conditioner		3,000 lbs	

Vapor-sealed room located on 3rd floor of 3 story office building (remodeled office area). Raised Unistrut floor acts as air conditioning plenum. False ceiling of acoustical tile acts as return plenum. Room surrounded on three sides with thermopane and metal partitions, fourth side tile and concrete wall. Fire proof tape vault equipped with fire door and metal storage cabinets.

B & W

Power, computer	52 Kw	59 KVA	0.88 pf
Volume, computer		12,000 cu ft	
Volume, air conditioner		3,600 cu ft	
Area, computer		1,500 sq ft	
Area, air conditioner		300 sq ft	
Room size, computer		30 ft x 50 ft	
Room size, air conditioner		30 ft x 10 ft	
Capacity, air conditioner		32 Tons	
Weight, computer		19,600 lbs	

Raised floor acts as cable raceway and as plenum for 20% of air flow. False ceiling provides duct work for return air. Concrete block building.

BRC

Power, computer	85 Kw	57.70 KVA	0.70 pf
Power, air condit	146 Kw	47.5 KVA	0.85 pf
Volume, computer		22,000 cu ft	
Volume, air conditioner		8,800 cu ft	
Area, computer		2,200 sq ft	
Area, air conditioner		550 sq ft	
Room size, computer		46 ft x 48 ft	
Room size, air conditioner		23 ft x 24 ft	
Floor loading		250 lbs/sq ft	
		1,000 lbs concen max	
Capacity, air conditioner		40 Tons	
Weight, computer		30,482 lbs	
Weight, air conditioner		3,430 lbs	

Installed false floor, which is used as a plenum, erected walls and partitions, and added power to the available power.

BCCF

Power, computer	70.6 Kw	78.2 KVA	0.90 pf
Volume, computer		15,200 cu ft	
Area, computer		1,580 sq ft	
Weight, computer		37,805 lbs	

208V, 60 cycle 3 phase, 4 wire, power is required. Raceways only. Normal plant air conditioning piped through ceiling and some through floor.

Dow

Power, computer, w/peripheral equip.	58 KVA/75 amperes
Volume, all equip	9,912 cu ft
Volume, computer	1,965 cu ft
Volume, air conditioner	1,917 cu ft
Area, all equip	1,239 sq ft
Area, computer	312 sq ft
Area, air conditioner	231 sq ft
Room size	21.5 ft x 59 ft
Floor loading	13 lbs/sq ft

Floor loading		400 lbs concen max	
Capacity, air conditioner		21 to 25 Tons	
Weight, computer		2,850 lbs	
Weight, air conditioner		800 lbs	

Building is brick. Computer room is on raised floor in basement, with plenum of about 12". Also false ceiling. Power cables are below floor in plenum.

Hoffman

Power, computer	82 Kw	88 KVA	
Power, air condition	60 Kw	60 KVA	
Volume, computer		12,000 cu ft	
Volume, air conditioner		1,600 cu ft	
Area, computer		1,500 sq ft	
Area, air conditioner		200 sq ft	
Room size, computer		50 ft x 30 ft	
Room size, air conditioner		20 ft x 10 ft	
Floor loading		15 lbs/sq ft	
		825 lbs concen max	
Capacity, air conditioner		40 Tons	
Weight, computer		25,275 lbs	

False ceiling with return air ducting above, plenum chamber false floor for entry air, cooling tower on roof for air conditioner, and floor registers behind each unit to regulate inlet air flow have been installed.

SKFL

Power, computer	44 Kw	52 KVA	0.86 pf
Power, air conditioner		16 KVA	0.85 pf
Volume, computer		24,100 cu ft	
Volume, air conditioner		9,000 cu ft	
Area, computer		2,590 sq ft	
Area, air conditioner		750 sq ft	
Room size, computer		31 ft 6 in x 66 ft 4 in	
		15 ft 4 in x 20 ft 7 in	
		15 ft 4 in x 12 ft	
Room size, air conditioner		30 ft x 25 ft	
Floor loading		60 lbs/sq ft	
Capacity, air conditioner		50 Tons	
Weight, computer		28,000 lbs	
Weight, air conditioner		6,400 lbs	

New air conditioning equipment room constructed to house equipment. It is steel framed with asbestos siding and metal deck roof (insulated).

Existing office area was modified to house computer, high speed printer and engineer's office. General description of modifications is as follows: New aluminum raised floor supplies conditioned air. One large return air grill installed at end of room. There is no ceiling supply or return system. New CO_2 fire protection system installed under raised floor. Original acoustical metal pan ceiling, Hauserman partition walls and lighting arrangement are used. New Power feeds installed to computer and air conditioning equipment.

SRI

Power, computer	127 Kw	150 KVA	0.85-0.95 pf
Power, air condi	33 Kw	45 KVA	0.85-0.95 pf
Volume, computer		8,800 cu ft	
Area, computer		1,100 sq ft	
Room size		30 ft x 40 ft	
Floor loading		100 lbs/sq ft	
		200 lbs concen max	
Capacity, air conditioner		35 Tons	

The computer rests on a raised floor which provides space for an air plenum and for cable connections. The return air is conducted through the false ceiling which again acts as a plenum.

Upjohn

Power, computer	129 Kw	147 KVA	0.98 pf
Power, air condi	29 Kw	29 KVA	0.99 pf
Volume, computer		22,000 cu ft	
Volume, air conditioner		11,400 cu ft	
Area, computer		2,000 sq ft	
Area, air conditioner		950 sq ft	
Room size, computer		40 ft x 50 ft	
Room size, air conditioner		30 ft x 31.5 ft	
Floor loading		250 lbs/sq ft	
Capacity, air conditioner		86 Tons	
Weight, computer		25,000 lbs	
Weight, air conditioner		11,000 lbs	

False floor installed which acts as air conditioning plenum, provides space for connecting cables and houses the sprinkler heads.

Calif Tech

Power, computer	40 Kw	42.5 KVA	0.94 pf
Volume, computer		200 cu ft	
Area, computer		130 sq ft	
Area, air conditioner		200 sq ft	
Room size, computer		1,000 ft^2	
Room size, air conditioner		230 sq ft	
Capacity, air conditioner		25 Tons	
Weight, computer			

False ceiling, lighting, air plenums, exhaust hoods, floor trenches, floor covering, power inlets, picture window, paint.

Cornell

Power, computer	40 Kw	50 KVA	0.80 pf
Power, air conditioner	28 Kw	34 KVA	0.80 pf
Volume, air conditioner		800 cu ft	
Area, computer		2,500 sq ft	
Area, air conditioner		100 sq ft	
Capacity, air conditioner		45 Tons	
Weight, computer		40,000 lbs	
Weight, air conditioner		1,100 lbs	

False ceiling, elevated floor, motor alternator and compressor room.

Georgia Tech

Power, computer	80.1 Kw	54.4 KVA
Area, computer		254 sq ft
Area, air conditioner		175 sq ft
Room size, computer		1,560 sq ft
Room size, air conditioner		250 sq ft
Capacity, air conditioner		40 Tons
Weight, computer		27,500 lbs

Renovate existing 70-year-old stone building; remove partitions; poured slab floor with raceways; no structural modifications. Air conditioner is shared with IBM 650 and EAM.

Deere

Power, computer	67.43 Kw	61.43 KVA.
Area, computer		241.85 sq ft
Room size		1,300 sq ft
Floor loading		250 lbs/sq ft
Weight, computer		27,903 lbs

208V, AC, 60 cycle.

PRODUCTION RECORD

Manufacturer

Number in current operation	42
Time required for delivery	6-8 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Purchase Price	Monthly Rental
220 Primary System	$320,000	$7,800
Data Processor-Model 220 (includes automatic floating-point arithmetic)		
Memory Control - Model 380		
Core Storage Unit - Model 381-1 (accommodates up to 5,000 words)		
Core Assembly -Model 382 (two assemblies provided)		
Power Control - Model 400		
Power Supply - Model 401		
Control Console - Model 415		
Supervisory Printer - Model 465		
Photoreader - Model 440 (1,000 characters per second)		

220 Primary System further includes:
Numeric keyboard and interval timer (as part of the Control Console), desk and chair; selection of five keynote panel colors - light blue, grey, dark blue, brown, and green.

Cardatron 220 Primary System	107,200	2,735
Cardatron Control I - Model 510		
Cardatron Control II - Model 511		
Cardatron Input - Model 512		
Cardatron Output - Model 513 (120 character)		
Magnetic Tape Control-Model 550	45,000	1,200
Magnetic Tape Storage-Model 551	21,450	635
Datafile - Model 556	49,500	1,475
Photoreader - Model 440 (1,000 characters per second)	8,000	225
Paper Tape Punch - Model 470 (60 characters per second)	3,400	100
Supervisory Printer - Model 465	9,600	300
Supervisory Printer - Model 464 (less-Off-line Reader)	7,000	225
Cardatron Input - Model 512	29,500	715
Cardatron Output - Model 513 (120 character)	31,200	820
Core Storage Unit - Model 381-2 (accommodates second 5,000 words)	27,000	800
Core Assembly - Model 382 (1,000 words each)	18,000	500
High Speed Printer Control- Model 261 (minimal control features)	125,000	3,450
High Speed Printer Control- Model 271	144,000	3,950
High Speed Printer Control- Model 281 (maximal control features)	158,900	4,350
High Speed Printer - Model 272	84,550	2,255
Tape Perforator & Verifier- Model 455	8,100	220
Tape Perforator Format Merger- Model 456	3,300	90
Paper Tape Concerter - Model 472	17,000	500

220 System Expansion

Cardatron system may be expanded to a total of seven (7) input or output units added in any combination.

Core storage may be expanded to 10,000 words in increments of 1,000 words (one (1). Cord Assembly required for each 1,000 words). Core storage beyond 5,000 words requires the addition of one (1) Core Storage Unit.

Paper-tape system may be expanded to ten (10) Photoreaders for input. As many as ten (10) Paper-Tape Punches or Supervisory Printers, added in any combination, may be used for output.

The magnetic tape system may be expanded to a total of ten (10) Magnetic Tape Storage Units, all associated with the single Magnetic Tape Control. A maximum of twelve (12) Magnetic Tape Storage Units may be used with a 220 system that includes High Speed Printers.

Each High Speed Printer can use up to two (2) Magnetic Tape Storage Units. Two (2) High Speed Printers may be used with a 220 system, one (1) of which may be directly coupled to the Data Processor.

Burroughs Line Printer, Model 289

For on-line use in the Burroughs 205 and 220 Cardatron Systems

	Lease (Per Month)	Purchase Price
Standard Features:		
Immediate-access clutch	$850	$ 36,000
Two triple panel manual plugboards		
Five 2-position pilot selectors		
Eight 5-position co-selectors		
Five 4-position Cardatron selectors		
Two digit selectors		
Twenty symbol selectors		
One half-time emitter		
Ten filters		
Six carriage skipping channels and one overflow channel		
Pluggable zero and asterisk print control		
Optional Features:		
Group of five 2-position pilot selectors	10	250
Group of four 5-position co-selectors	5	200
Group of Ten symbol selectors (maximum two groups)	15	600
Group of two digit selectors	10	200
Group of ten filters	3	70
Additional plugboard		100

Burroughs Card Output Unit - Model 292

For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch	150	5,800
Six 5-position co-selectors		
Five 2-position Cardatron selectors		
One digit emitter		
One half-time emitter		
One single panel manual keyboard		
Optional Features:		
Double punch and blank column detection device (Group of 20-positions-maximum four groups)	16	740
Offset stacker	10	225
Additional plugboard		50

Burroughs Card Input Unit - Model 293

For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch	300	14,000
Five 2-position pilot selectors		
Eight 5-position co-selectors		
Two digit selectors		
One half-time emitter		
One single panel manual keyboard		

Optional Features:	Lease (Per Month)	Purchase Price
Group of five 2-position pilot selectors	$10	$250
One additional digit selector	10	200
Additional plugboard		50

All prices are subject to change without notice.

Outline of Sale Policy

A standard Burroughs Corporation sales or rental agreement will be executed at the time of sale or lease.

Prices are F.O.B. Pasadena, California.

Sales, use or other taxes imposed directly on the sale or rental of Burroughs machines by Federal, State, or local governments will be borne by the purchaser or lessee.

Maintenance service for purchased equipment on a continuing or on-call basis is available by contract through a staff of qualified service engineers stationed in major cities across the country. Maintenance service for leased machines is provided as required to keep the equipment in good operating condition.

Rental agreements are effective for one year from the date installation of the equipment is complete, and remain in effect thereafter until terminated by either party upon 90 days' written notice.

Machines under lease may be purchased at any time at the prices in effect at the time the lease is executed, less a credit of 40% of all rentals paid, up to a maximum of 60% of the purchase price.

Guarantee and Installation Policy

Except for expendable items, such as tubes, diodes, fuses, lamps, and neon indicators, all equipment is guaranteed for one year against defective material or workmanship.

The purchase or lease of Burroughs machines includes the following:

1. Necessary manuals which describe operation of the equipment.
2. The services of trained personnel to supervise installation in the customer's plant.
3. Prescribed training of the customer's employees by qualified Burroughs instructors in programming, operation and maintenance procedures and techniques.

The Burroughs "100/70 Plan" for rental of 220 Data Processing Systems

The 100/70 Plan, is a new approach to the rental of major scale data processing equipment. To qualify for rental under the "100/70 Plan", a system which normally rents for at least $15,800 per month must be ordered ($11,100 per month under "100/70").

As long as monthly usage remains at 100 hours or less, only 70% of the monthly rental must be paid. The lessee has the option to convert to the regular 176-hour standard rental plan at any time his work load demands the additional time. However, once the lessee has exercised the option to convert to regular 176-hour monthly contract, he may not revert back to the "100/70 Plan".

The "100/70 Plan" applies to only on-line equipment, excluding the High Speed Printer System, and the Input/Output Cardatron Equipment, however the monthly rental of any off-line equipment may count toward the minimum total rental of $15,800 per month.

Use time for the 100 hours is defined as the time during which the system or any components thereof is in operation, exclusive of preventive or remedial maintenance time: when system components are normally inter-connected the sum of the regular monthly charges for these components is to be taken as the regular monthly charge for the system in determining the hourly additional use rate.

Burroughs Corporation will provide the necessary parts and service to maintain the equipment in good operating condition as required during its regular business hours, eight a.m. to five p.m., Monday through Friday excluding holidays.

Maintenance/Service Contracting

Burroughs will keep the machines in good operating condition. All costs of maintenance (except for ribbons and supplies) will be borne by contractor unless the required maintenance is due to the fault or negligence of the lessee.

Burroughs shall provide maintenance service during all periods of operation. Upon mutual agreement, contractor will assign "on site" service engineers.

The lessee will provide adequate storage space for spare parts, and adequate working space including heat, light, ventilation, electric current and outlets, for the use of the service engineers. These facilities will be within a reasonable distance of the machines to be serviced and will be provided at no cost to contractor.

Preventive (scheduled) maintenance for each machine will be furnished on a schedule which is mutually acceptable to the lessee and Burroughs and which is consistent with the operating requirements.

Burroughs will always be responsive to the maintenance requirements of the lessee. All remedial (unscheduled) maintenance will be performed promptly after notification to contractor's nearest service location that a machine is inoperative.

If contractor is unable to restore a machine to good operating condition and the machine remains inoperative for a continuous period of 24 hours during scheduled work days of the installation from the time the lessee notifies contractor that the machine is inoperative, and it is determined that (1) the machine became inoperative through no fault or negligence of the lessee, and (2) the lessee's production requirements were interfered with as a result of the machine breakdown, Burroughs will grant to the lessee a credit for each hour the machine eas inoperative. Such credit shall be 1/176th of the monthly charge for the inoperative machine plus 1/176th of the monthly charge for an interconnected machine not usable as a result of the breakdown; provided, however, that the credit granted for each machine shall in no instance exceed 1/30th of the monthly charge for the machine in each 24 hour period.

Burroughs will use its best efforts to assist the lessee in procuring service on equipment compatible with that used by the lessee, to meet emergencies such as a major breakdown, conversion from one system to another, unforeseen peak loads, etc. The lessee, at its option, may accept or reject the offer of use of emergency equipment. If accepted, the cost of such services, if any, will be arranged on an individual installation basis.

USA-SRDL

2,000 words storage, paper tape input, supervisory printer output, additional 2,000 words of storage, 4 magnetic tapes, paper tape punch, Cardatron (1 input, 2 output), all rent for $17,000/month, including service.

USN LBNS

Central Processor, 10,000 words core storage, supervisory printer, photoreader, paper tape punch, Cardatron with one input and four output units, ten magnetic tape storage units and high speed printer, printer control (medium) and one magnetic tape storage unit cost $1,209,117.

USAF ACIC

Purchase price for basic system, consisting of, data processor, memory control (2,000 words), power control, control console, supervisory printer, and photoreader is $320,000.

Purchase price for additional equipment, consisting of Cardatron Control I, Cardatron Control II, Cardatron Input, Cardatron Output, Cardatron Output for IBM 407, Cardatron Output for IBM 523, paper tape punch, additional core memory (3,000 words), magnetic tape control, and six magnetic tape storage units is $320,000.

USAF DCS/C ATC

220 Primary System and Cardatron I and II rents for $9,000/month.

Model 550, seven 551's, 470, 512, four 513's, 381-2 and 382 rent for $14,540/month.

TAC

$7,800/month (includes the data processor, control console, memory control, 2,000 words of core storage, supervisory printer, paper tape reader, power control), and $10,020/month includes the Cardatron Subsystem, magnetic tape control unit, magnetic tape storage unit, 3,000 words additional core, IBM 407 Printer, IBM 089 Card Read, and IBM 514 Card Punch.

USGS

The primary system, including 220 Data Processor, 380 Memory Control, 381-1 Core Storage Unit, 382 Core Assembly (2,000 words), 400 Power Control, 401 Power Supply, 415 Control Console, 465 Supervisory Printer, 440 Photo-Reader, rents at $7,800 per month, and the Cardatron Primary System, including the 510 Cardatron Control I, 511 Cardatron Control II, 512 Cardatron Input Unit, 513 Cardatron Output Unit, rents at $2,735 per month.

Abbott

220 Primary System with 5,000 words, Cardatron Primary System (1 in - 1 out), and magnetic tape control and 6 units cost $643,200.

Additional Cardatron output and peripheral equipment (IBM), i.e. 2-087, 2-523, 1-407 cost $129,950.

220 Basic System with Cardatron and 6 magnetic tapes rent at $16,005/month.

Additional Cardatron output and IBM peripheral equipment rent at $3,107/month.

B & W

Basic system including magnetic tape, printer, punch, reader and Cardatron rents at $21,500/month.

Off-line printer, sorter, reproducer, key punches, and verifier rent at $1,500/month.

Rents include maintenance.

BRC

1 Data processor, 1 memory core, 1 core storage unit, 1 core assembly, 1 power control, 1 power supply, 1 control console, 1 supervisory printer, and 1 photoreader cost $320,000.

1 Cardatron Control I, 1 Cardatron Control II, 1 Cardatron input, 2 Cardatron output, 1 magnetic tape control, 6 magnetic tape storage, 1 photoreader, 1 paper tape punch, 1 supervisory printer, 1 Cardatron output, 1 core storage unit, and 8 core assembly cost $484,400.

These rent for $7,800/month and $10,270/month respectively.

Maintenance cost $39,528 per year.

Dow

Primary system $7,800/month with 40% applicable to purchase price. Price approximately $320,000.

Rental/lease of peripheral equipment $6,220/month. Purchase price approximately $200,000 less 40% of rental price.

Basic computer was rented/leased for $7,800/month.

Rental rates for additional equipment

Punches	$100/month
Printers	300/month
Magnetic Tape Control	1,200/month
Magnetic Tape Storage	535/month
Cardatron	2,735/month
Magnetic Tape Storage	635/month.

Maintenance charges on peripheral equipment.

Hoffman

A 5,000 word Core Memory, a Cardatron, 5 Magnetic Tape Units, 2 1 KCPS Photoreaders, Supervisory Printer, IBM 407, 087, 521, and Paper Tape Punch cost approximately $840,000.

The X-Y Plotter cost $32,000.

Maintenance cost approximately $3,000/month.

SKFL

Rental Contracting and Rates for Basic System

Components - Basic System	Type	Monthly Rental
Data Processor	220	
Core Storage	381-1	
Memory Control	380	
Control Console	415	$ 9,300
Paper Tape Punch	470	100
Magnetic Tape Control	550	1,200
Magnetic Tape Storage	551	4,445
Cardatron Control	510	1,200
Cardatron Input	512	715
Cardatron Output (2)	513	1,640
High Speed Printer Control	271	3,950
High Speed Printer	272	2,255
	Total	$24,805

Rental Rates for Additional Equipment

Components - Additional Equip.		
IBM Printer	407	$ 880.00
IBM Card Punch	523	97.90
IBM Card Reader	548	242.00
	Total	$1,219.90

SRI

Power supply, arithmetic unit, console, paper tape reader, paper tape punch, console typewriter output, 2,000 word memory cost $320,000.

$18,000/1,000 words memory (to a total of 10,000 words), card equipment-buffer with read, write and punch facilities, approx. $138,400; magnetic tape control, approx. $45,000; magnetic tape units $21,450 (to a total of 10).

IBM 407, 523, 087, approx. $1,200/month rental.

Maintained by Burroughs (5 tapes, Cardatron 1 in-2 out, primary system) at approx. $2,900/month.

Upjohn

$1,090,000 for the system, which is maximum.

$29,075 per month for the system which is maximum.

Cal Tech

Gift from Burroughs.

Cornell

Data processor, 4 magnetic tapes, memory, Cardatron, paper tape equipment - $600,000.

$18,000 per year for maintenance.

Georgia Tech

Power supply, power control, data processor, memory, Cardatron, paper tape punch, supervisory printer, photoreader, magnetic tape control unit, four magnetic tape storage units, $310,000 (educational rate).

IBM 089, IBM 523, IBM 407, IBM 026 (2), IBM 056 $1,288 per month. 60% educational discount given by IBM.

Maintained by Georgia Tech personnel.

Stanford

Computer, console, photoreader, 2,000 words core, supervisory printer, power control and supply: $320,000.

Paper tape punch, Cardatron (1 input; 2 output), 6,000 words core, 5 magnetic tape storage units: $420,000.
IBM 523, 87, 407: approx. $1,100/month.
Maintenance $40,000/year.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	1	1
Analysts	6	6	6
Programmers	6	6	6
Coders	2	2	2
Librarians	1	1	1
Operators	2	3	4
Engineers	2	4	6
In-Output Oper	1	2	3
Tape Handlers	1	2	3

USA-SRDL

	One 8-Hour Shift
Supervisors	1
Analysts & Programmers	9
Clerks	5
Operators	3

Operations tends toward open shop.
Courses in programming given monthly for technical personnel.

USN LBNS

	One 8-Hour Shift Used	Recommended
Supervisors	3	3
Analysts	6	7
Programmers	11	10
Clerks	3	4
Librarians	1	1
Operators	2	2
In-Output Oper	7	7
Tape Handlers	1	1

Operation tends toward closed shop.
On-site 200 hour course, developed by Shipyard, conducted by Burroughs Corporation. Trainees selected from composite Civil Service Examination (portions applicable from FSEE, EDP, Math, etc.). On-site 40 hour High Speed Printer Course by Burroughs. On-site 80 hour EDP-HSP Course in Operations by Burroughs. On-site courses in Tape and Program Principles by Shipyard - total 120 hours.
All personnel were selected and hired from within the Shipyard. Centralized analysis, programming and operations of all EAM and EDP. EAM personnel excluded (key punch and tabulating). Librarians assist tape handlers.

USAF ACIC

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors	5	
Analysts	2	
Programmers	12	
Clerks	5	
Operators	3	3
Engineers	2	
Technicians	5	
In-Output Oper	6	5

Programmers. The programming personnel are divided into groups, each group performing in various fields of application, such as Civilian Payroll, Manhour and Cost Accounting, Chart Inventory and Technical Computations.
Operators. Consists of two console operators and four computer operators. Personnel are divided into two groups and work split shifts. Console operators are also responsible for Tape Library duties. Computer operators, in addition to operating computer, are also responsible for operating supporting EDP equipment.
Engineers & Technicians. Are employees of Burroughs Corporation located at this installation to maintain the 220 computer.
Operation tends toward closed shop.
Methods of training used include courses in Programming, Coding and Operating Techniques presented by manufacturer, various related courses presented by the Air Force, and on-the-job training.

USAF DCS/C ATC

Operation tends toward closed shop.
A combination of formal programming training provided by the manufacturer and on-the-job training.

ATC

	One 8-Hour Shift Used	Recommended
Supervisors	3	5
Analysts	3	5
Programmers	11	17
Clerks	1	2
Librarians		1
Operators	2	2

Operation tends toward closed shop.
Classroom instruction by a Burroughs Corporation instructor and closely supervised on-the-job training.

USGS

	One 8-Hour Shift	
Supervisors	2	
Analysts, Programmers & Coders	8	
Clerks	2	
Librarians-Operators	2	
Engineers-Technicians	2	Burroughs Corp. personnel

Operation tends toward open shop.
Methods of training includes schools sponsored by Manufacturers of equipment and on-the-job training.

Abbott

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts, Prog. & Coders	8	12
Librarians	1	1
Operators	1	2
Engineers	2-3	3

Methods of training analysts is three week formal course and work with experienced analyst. Operators are given on-the-job training with programmers and engineers.

B & W

	One 8-Hour Shift
Supervisors	3
Analysts-Programmers	12
Operators	3
In-Output Oper	3

Operation tends toward closed shop.
Methods of training used includes two weeks lectures followed by on-the-job training.

BRC

	One 8-Hour Shift Used	Recommended
Supervisors	2	2
Analysts	2	3
Programmers	4	6
Coders	1	2
Clerks	2	2
Librarians	1	1
Operators	3	3
Engineers	3	3

Operation tends toward open shop.

Programmers are trained by supervisory personnel and operators are trained by Burroughs Corporation. They are capable of operating the computer, input and output equipment and all other peripheral equipment.

BCCF

Since the computer is on the premises of one of the manufacturer's (Burroughs) plants, there is a section responsible for the activities of the three systems within the Computer Facilities. The three systems are the Burroughs 205, Burroughs 220, and Burroughs E101. The Computer Facility consists of the manager, two computer specialists, one operator, and one scheduler. With the exception of the operator who is on swing shift, the rest of the staff is on prime shift.

There are three engineers on duty 0400 - 1300 hours for the 220. There is one engineer on standby from 0000 - 0900 hours for all systems in the plant. Other hours are covered by 15 minute on-call engineers. The aforementioned staff is adequate for good system reliability.

Dow

	One 8-Hour Shift
Supervisors	1
Analysts	7
Programmers	2
Clerks	1
Operators	1
In-Output Oper	1
Tape Handlers	1

Operation tends toward open shop.

Training classes for programmers 2 or 3 times a year. Also current information on programming is released regularly.

Hoffman

	One 8-Hour Shift	
	Used	Recommended
Programmers	1	1
Operators	1	1
Engineers	1	1
Technicians	3	3
In-Output Oper	1	1

Operation tends toward open shop.

Methods of training used includes manufacturer's school.

HMPD is authorized to sell computer time to other government contracts at a rate of approximately $50 per hour, which is about one-third the rate normally charged on a service bureau basis for a similar configuration of equipment.

Interested parties are advised to contact:

Edmund M. DiGiulio
Hoffman Military Products Division
3717 South Grand Avenue
Los Angeles 7, California

SKFL

	One 8-Hour Shift	
	Used	Recommended
Supervisors	3	3
Analysts	6	6
Programmers	8	8
Operators	4	5
Engineers	3	2

Operation tends toward open shop.

Methods of training used includes basic punched card indoctrination, formal programming training, formal principles of operation, on-the-job training, and miscellaneous related courses.

SRI

Operation tends toward open shop.

Methods of training used is tutorial, since we add only one or two persons at a time.

The staff is small. Programmer encompasses parts of positions called analyst, programmer, coder, operator.

SRI has a permanent 1 shift clerk-scheduler-librarian-operator (1 person) and a 1 shift (second shift) operator.

Upjohn

	One 8-Hour Shift
Supervisors	1
Analysts	9
Librarians	1
Operators	2

Operation tends toward closed shop.

Methods of training used includes lectures plus time on the system. Only 2 additional operators are required for the second shift.

Cal Tech

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	1	1
Clerks	1	1
Engineers	1	1

Operation tends toward open shop.

Non-credit coding courses given continuously to all interested school personnel.

Operation completely open-shop. All analysis and coding done by users.

Cornell

	One 8-Hour Shift
Supervisors	1
Analysts	2
Programmers	4
Operators	1
Engineers	4

Georgia Tech

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	2	2
Programmers	3	4
Librarians	1	1
Operators	2	2
Engineers	2	2
Technicians	1	

Operation tends toward open shop.

For the most part on-the-job training prevails. Some personnel are sent to schools operated by the manufacturer's of the equipment concerned.

Stanford

	One 8-Hour Shift
Supervisors	2
Programmers	2
Clerks	2
Operators	1
Engineers	1
Technicians	1

Operation tends toward open shop.

Methods of training used includes formal classroom.

Deere

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1/2	1
Analysts	2	3
Programmers	2	3
Clerks	1/2	1/2
Operators	1	2
In-Output Oper	1/2	1
Tape Handlers	1/2	1/2

Operation tends toward open shop.

Method of training used is primarily on-the-job with some Burroughs technical training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USA-SRDL

Good time 34 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period 1 Oct 59 to 31 Mar 60
Passed Customer Acceptance Test 1 May 59
Time is available for rent to qualified outside organizations.

Arrangements can be made by other government organizations for computer time.

USN LBNS

Average error-free running period 8 hr. operating shift
Good time 69 Hours/Week (Average)
Attempted to run time 76 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.91
Above figures based on period 1 Jul 60 to 31 Jul 60
Passed Customer Acceptance Test 1 Jun 60
Time is not available for rent to outside organizations.

USAF ACIC

Good time 34.3 Hours/Week (Average)
Attempted to run time 36.7 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period 15 Jan to 15 Apr
Passed Customer Acceptance Test Feb 59
Time is not available for rent to outside organizations.

USAF DCS/C ATC

Average error-free runnung period 20 Hours
Good time 57 Hours/Week (Average)
Attempted to run time 59 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.965
Above figures based on period from Jan 60 to Mar 60
Passed Customer Acceptance Test 30 Jun 59
Time is not available for rent to outside organizations.

TAC

Good time 50 Hours/Week (Average)
Attempted to run time 51.9 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.963
Above figures based on period 1 Dec 59 to 30 Apr 60
Passed Customer Acceptance Test 21 Aug 59
Time is available for rent to qualified outside organizations.

Time can be made available to other government activities if an emergency arises.

USGS

Good time 42 1/4 Hours/Week (Average)
Attempted to run time 48 3/4 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.87
Above figures based on period 1 Jul 60 to 30 Jul 60
Passed Customer Acceptance Test 10 Nov 59
Time is available for rent to qualified outside organizations.

Abbott

Good time 72 Hours/Week (Average)
Attempted to run time 87 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.83
Above figures based on period 1 May 60 to 31 Aug 60
Passed Customer Acceptance Test Nov 59
Time is not available for rent to outside organizations.

B & W

Good time 43 Hours/Week (Average)
Attempted to run time 45 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.96
Above figures based on period from Dec 59 to Aug 60
Passed Customer Acceptance Test 4 Dec 59
Time is available for rent to qualified outside organizations.

BRC

Good time 53 Hours/Week (Average)
Attempted to run time 55 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period 6 Jun 60 to 7 Aug 60
Passed Customer Acceptance Test 6 Jun 60
Time is available for rent to outside organizations if the system is not being used for in-house work.

BCCF

Good time 133 Hours/Week (Average)
Attempted to run time 140 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Jan 60 to Jul 60
Passed Customer Acceptance Test Jun 59
Time is available for rent to outside organizations.

Dow

Good time 98 Hours/Week (Average)
Attempted to run time 100 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period from Jan 60 to May 60
Passed Customer Acceptance Test Aug 59
Time is available for rent to qualified outside organizations.

At present we are using computer about 470 hours a month and will probably continue to do so for 6 months.

SKFL

Average error-free running period 5.5 Hours
Good time 38.7 Hours/Week (Average)
Attempted to run time 49.2 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.786
Above figures based on period 1 Feb 60 to 31 Jul 60
Passed Customer Acceptance Test 31 Dec 59
Time is available for rent to qualified outside organizations.

Renting of computer time to outside concerns is on an "as available" basis. Currently have separately negotiated time buy-back agreement with manufacturer and cooperative time rental agreements with three additional organizations.

SRI

Average error-free running period approx. 12 Hours
Good time 36.80 Hours/Week (Average)
Attempted to run time 40.27 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.914
Above figures based on period 8 Feb 60 to 25 Jul 60
Passed Customer Acceptance Test 1 Mar 60
Time is available for rent to outside organizations.

Upjohn

Good time 64 Hours/Week (Average)
Attempted to run time 75 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period from Jul 60 to Aug 60
Passed Customer Acceptance Test 13 Oct 59
Time is not available for rent to outside organizations.

Cal Tech

Good time 151 Hours/Week (Average)
Attempted to run time 153 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.987
Above figures based on period 15 Mar 60 to 15 Apr 60
Passed Customer Acceptance Test 7 Mar 60
Time is not available for rent to outside organizations.

Cornell

Passed Customer Acceptance Test 15 Sep 59
Time is available for ent to outside organizations.

Georgia Tech

Average error-free running period 3 Hours
Good time 18 1/4 Hours/Week (Average)
Attempted to run time 19 1/4 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period 1 May 60 to 1 Aug 60
Passed Customer Acceptance Test 12 Aug 59
Time is available for rent to outside organizations.

The above figures were taken during an extensive modification period. The entire system is available for rent at $100 per hour for research projects requiring the use of our staff.

Stanford

Time is available for rent to qualified outside organizations.

Deere

Good time 45.6 Hours/Week (Average)
Attempted to run time 53.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period 4 Jan 60 to 28 Aug 60
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Parallel access to storage (11 digits per word).

Automatic storage to storage transfer at 184,000 digits per second.

Direct storage addition, tallying, and program loop control.

Multi-functions instructions, B register, partial word arithmetic, and automatic tallying-reduces program length.

Specially designed logic instructions and controls to simplify programming.

Automatic program "float in".

Facilities for inspection and storage of information on the control console.

Ten program control switches provides flexible manual-control of the computer operation.

An interval timer is available for problem timing.

Magnetic tape subsystem provides file capacity of over 500 million digits, any one of which is readily available in seconds.

Independent bi-directional searching on any part of the first word of any record (for fast file access).

Independent "scanning" on any part of any of the first 10 words of any record.

Updated records may be recorded on the same tape area (selective updating for low-volume file access processing).

Updated records may be recorded on new tape area (total updating for high-volume file access processing).

Selectable record length - 110 to 1,100 digits.

Tape flow areas automatically bypassed.

Automatic parity checking, digit count, and word count.

A complete buffering and editing system connects card readers, card punches, and line printers to the 220 Data Processor.

Complete facilities for input and output with paper tape are available.

Special recommended procedures for magnetic tape labelling, storing, shipping, and protection from humidity, temperature, electrical, fire, or other damage:

220 Magnetic Tape Handling: BMTR1 is a general-purpose tape-handling routine which is provided to any installation by the Burroughs Corporation, to insure the most efficient handling of any problems in regard to the use of the magnetic tape system. The operating environment is the same as that specified for the 220 System.

Required storage environment: Temperature, 65 degrees to 80 degrees Fahrenheit; relative humidity, 40% to 60%; electromagnetic fields, not to exceed three oersteds; where radiation is not dangerous to people; free from excessive vibration; dust proof containers; reels placed in boxes and stored on edge in a vertical position. Minimum storage file at least one year when stored as above.

USN LBNS

Magnetic tapes are stored in a fire resistant plaster wall vault built in a concrete warehouse building with automatic overhead sprinkler system. Tapes are filed in individual plastic dustproof containers in an upright position in steel filing cabinets. Tape reels have been numbered serially to identify tapes of varying lengths and block size. Plain masking tape is used to label reels to indicate the pertinent computer application, tape file identify, day's business and tape unit on which created. The storage and operating environment is:

Temperature: 65° to 80° F
Relative Humidity 40% to 60%

USAF ACIC

Magnetic-core internal storage results in high computing speeds and multiple input-output devices provide considerable flexibility in the system. Full-dimensional expansion allows for additions to the system as need arises, such as multiple tape data file, etc.
Magnetic tapes are maintained in the computer room, which is controlled for the proper temperature and humidity. Equipment requirements for fire resistant tape storage have been surveyed and will be submitted for procurement action, subject only to fund limitations.
Remote duplicate storage of critical data and program tape records is in the process of being accomplished. Negotiations are in progress to obtain a surplus underground ammunition storage location from the Department of the Army.

TAC

Outstanding system features include Cardatron system for buffered on-line input and output. This system (Cardatron) also offers complete 80 column alphabetic input and 120 column alphabetic output. Magnetic tape system with ability to search for records independent of main computer operation, and to do selective updating (i.e., to write an updated record back onto the same area of tape from which it was previously read. This precludes the necessity of completely copying a tape during an updating run. High-speed paper tape reader as additional input to system. Very comprehensive control from console for operator intervention and debugging. Magentic tape system with two separate data lanes per tape with independent search and selective update features.

Tapes are identified by a Job Number. Tapes are stored in cabinets commercially produced solely for such purpose. "Original" tapes are protected from humidity and temperature by storage in the computer room. "Duplicate" (copies) tapes are stored in an alternate location to provide for reconstruction of operation in the event of destruction of the "original" tapes (fire, etc.)

Abbott

Unique system advantages include magnetic tape search and scan are not computer interlocked.

B & W

Magnetic tapes are stored in a controlled atmosphere computer room.

BRC

Outstanding features include decimal operation, built-in automatic floating point, partial-word oper-

ation, two-way index register, record transfer, and programmed decisions.

Unique system advantages include complete register display, information entry and inspection, ten program switches, simultaneous, independent operation, automatic editing and format control, choice of formats, and unrestricted alphanumeric operation.

Tapes are labeled, stored, re-edited and pre-blocked periodically. They are wrapped in aluminum foil when shipped. The tapes are stored in the computer room which has temperature and humidity control.

BCCF

Outstanding features include a very compreehnsive magnetic tape system. There are 18 distinct commands, variable length records, buffered searching and scanning without having fixed addresses. The use or a Datafile greatly enhances the use of an operating system. Excellent programming systems are available, such as the Burroughs Assembler - Compiler, Blessed Assembler - Compiler, ALGOL 58 Algebraic Compiler, and the Star 2 Assembler.

Dow

System is an inexpensive high speed computer. Tapes are stored in the computer room. System needs magnetic tape to high speed printer and cards to magnetic tape conversion facility.

SKFL

Outstanding features includes a sophisticated tape sub-system.

Unique system advantages include a forward and reverse search and scan on tape sub-system dual lane tape.

Handling magnetic tape includes the following procedures:

Labelling

- Job Identification
- Internal Positive Labelling
- External Physical Labelling

Storing

- Computer site - open 52 reel racks
- Retention site - open 52 reel racks

Protecting

- Continuous conditioned atmosphere
- Computer site protected with semi-auto. CO_2 subfloor system plus CO_2 hand extinguishers
- Automatic power shutdown in event the site fire alarm is actuated
- 98% of site construction and components are of fire proof materials.

Upjohn

Outstanding features include a large core storage.

Magnetic tape is stored under same conditions as computer room - in a tape library. Each reel numbered and a history maintained by this number.

Georgia Tech

Outstanding features include a completely buffered card input and output, completely buffered magnetic tape sub-system, and the ability to simulate the Burroughs 205 System with a speed-up of about 3 to 1.

Magnetic tape is stored in the computer room where the humidity stays between 40 and 60% and the temperature between 70°F and 80°F. It is not protected from fire damage but is stored in metal cabinets.

Deere

Magnetic file label on beginning of tape and physical file label on reel containing file number, reel number, program origin, date, size and type of record. Current files stored in Remington Rand portable storage trucks in air conditioned and humidity controlled computer room. Historical files and unused tape stored in fireproof air conditioned vault.

FUTURE PLANS

USA-SRDL

Plans are being made to do the Laboratory's technical reporting by means of the computer.

USAF ACIC

At present, work effort is being concentrated on conversion of card programs to magnetic tape programs. In addition to the present programs, proposed systems will include personnel administration, consisting of strength reports, workload and staffing, employment requirements, turnover, wage schedules, retention lists, etc.

It will also include mechanization if Air Force film distribution. Air Force projection films are provided for training purposes to the Air Force and to other organizations upon request. This operation will provide for maintenance of film, inventory of film, process of film requisitions and returns.

A new component under consideration is the Burroughs Datafile, a magnetic tape storage device designed for applications requiring large-volume storage. With a maximum capacity of approximately 50 million digits, the Datafile has the ability to skip from one part of a file to another without searching through all the records stored.

Consideration is also being given to substituting the IBM 1401 input-output system for the input-output components presently being used. It appears a substantial increase in capability can be obtained at no increase in cost.

USAF DCS/C ATC

Certain of the existing programs will be refined so that they will operate more efficiently.

The inquiry service provided DCS/Personnel will be expanded duting the coming fiscal year.

TAC

The Burroughs 220 System currently installed will be augmented with additional components (additional core memory, additional tape units, etc.) as required by the increased workload.

A study is currently underway to determine the feasibility of supplementing the Burroughs 220 System with an IBM 1401 System, using a "black box" for language translation.

Abbott

New components are to be card reader 300 cards/min, card punch 200 cards/min, additional core storage (to 10,000 words), and additional tape storage units.

BRC

There is a possibility we may obtain additional peripheral equipment such as a high speed printer and/or another line printer.

BCCF

Replacement of present card input-output equipment with Burroughs equipment. Burroughs Model 289 Line Printer at 150 lines/min, a Burroughs Model 292 Output Unit at 100 cards/min, and a Burroughs Model 293 Input Unit at 300 cards/min.

SKFL

Proposed applications include financial (billing, sales analysis, and payroll), marketing (professional representative expense accounting, listing and selection for international markets, and statistical manipulation of data), manufacturing (inventory reporting and control), and research (statistical manipulation of laboratory data).

Georgia Tech

Plans are being considered to increase the internal speed of the system by about 20%. Some form of off-line magnetic tape equipment is being considered.

INSTALLATIONS

U. S. Army Signal Research & Development Laboratory
Fort Monmouth, New Jersey

Long Beach Naval Shipyard (Code 110)
Long Beach 2, California

USAF Aeronautical Chart & Information Center
2d and Arsenal Streets
St. Louis 18, Missouri

Statistical Services Directorate, DCS/Comptroller
Headquarters Air Training Command
Randolph Air Force Base, Texas

Headquarters, Tactical Air Command
Langley Air Force Base, Virginia

U. S. Geological Survey
Department of Interior
18th and C Streets, N. W.
Washington, D. C.

Abbott Laboratories
1400 Sheridan Road
North Chicago, Illinois

Allstate Insurance Company
Pasadena, California
Detroit, Michigan
Murray Hill, New Jersey
Harrison, New York

The Babcock and Wilcox Company
Van Buren Avenue
Barberton, Ohio

Burroughs Research Center
Paoli, Pennsylvania

Burroughs Corporation, Computer Facility
460 Sierra Madre Villa
Pasadena, California

The Dow Chemical Company
Computations Research Laboratory
687 Building
Midland, Michigan

Hoffman Military Products Division
3740 So. Grand Avenue
Los Angeles 7, California

Smith Kline & French Laboratories
1500 Spring Garden Street
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Stanford Research Institute
Menlo Park, California

The Upjohn Company
7171 Portage Road
Kalamazoo, Michigan

California Institute of Technology
1201 East California Street
Pasadena, California

Cornell University
Rand Hall, Computing Center
Ithaca, New York

Georgia Institute of Technology
Rich Electronic Computer Center
Atlanta, Georgia

Stanford University
Stanford, California

John Deere Waterloo Tractor Works
400 Miles Street
Waterloo, Iowa

The First Pennsylvania Banking & Trust Company
15th and Chestnut Streets
Philadelphia 1, Pennsylvania

BURROUGHS D 103

Burroughs D103 Computing System

MANUFACTURER

Burroughs Corporation

APPLICATIONS

Real-time control computer

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20
Binary digits/instruction	7
Instructions/word	1
Instructions decoded	64
Arithmetic system	Floating point
Instruction type	One address

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec
Add	5
Mult	65
Div	80
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Bin Dig/Word	Access Microsec
Drum	3,770	96	
Core Registers	20	20	5

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	2,200
Diodes	14,000
Magnetic Cores	1,200

CHECKING FEATURES

A diagnostic program is performed every 19 milliseconds.

Parity checks are made on memory read-in and read-out.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	29 Kw
Volume, computer	450 cu ft
Capacity, air conditioner	9 Tons

ADDITIONAL FEATURES AND REMARKS

Outstanding features are real-time, control designed for installation in an experimental army air defense system. This computer evaluates and controls assignment of up to 20 batteries.

Computing system performs many laborious, detailed calculations to assist commanders in getting maximum effectiveness for their weapons.

BURROUGHS D104

AN/FST-2 Coordinate Data Transmitter

MANUFACTURER

Burroughs Corporation

APPLICATIONS

Special purpose digital data processor for real time processing of radar data, as input to SAGE Central Computer. Dual equipment. System was designed for U. S. Air Force. All data given is for simplex equipment, except for power, space, weight and sight preparation requirements. These data are given for the duplex equipment.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Digits per output word	52
Timing	Synchronous
Operation	Concurrent

System is wired to perform a special purpose program.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Drum	512	48	3,000
Core	512	32	3,000
Drum	1,536	48	9,000

Access times are for cyclic address

INPUT

Media	Pulse Period Microsec
Radar Surveillance Video	3 or 6
Radar Surveillance Video	3 or 6
Radar Height Video	0.5
Radar Height Video	2

Input information is in real-time from radar.

OUTPUT

Medium	Speed
Telephone Line	1300 cycle carrier

600 52-bit words are transmitted on telephone line per 12 second antenna scan.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	7,000
Diodes	25,000
Transistors	4,200

The total component count is 160,000 elements.

CHECKING FEATURES

System has built-in automatic parity and logic alarms.

Marginal checking may be performed at the operator's option.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Data is given for a duplex system

Power, computer	60 Kw	67.5 KVA
Power, air conditioner	100 KVA	
Volume, computer	1,775 cu ft	
Area, computer	943 sq ft	
Room size, computer	23 ft x 41 ft	
Room size, air conditioner	20 ft x 36 ft	
Weight, computer	39,750 lbs	

A false floor has been installed to cover cable runs and air conditioning ducts.

The building is RF shielded to reduce field strength from nearby radar sets.

PRODUCTION RECORD

Number produced to date	100
Number in current operation	85
Number in current production	134
Number on order	134

Time required for delivery from receipt of order
12 months

Data is as of 31 July 1960.

PERSONNEL REQUIREMENTS

Personnel requirements include one engineer and 2, 5, and 7 technicians for one, two and three 8-hour shifts respectively.

Training includes U. S. Air Force sponsored schooling and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The duplex equipment gives an availability of over 99.7%.

Worst-case design is utilized in digital circuitry.

FUTURE PLANS

U. S. Air Force sponsored improvement program intends to add new state of the art features modifications to increase capability.

BURROUGHS D 105

Atlas Model III Guidance Computer

MANUFACTURER

Burroughs Corporation

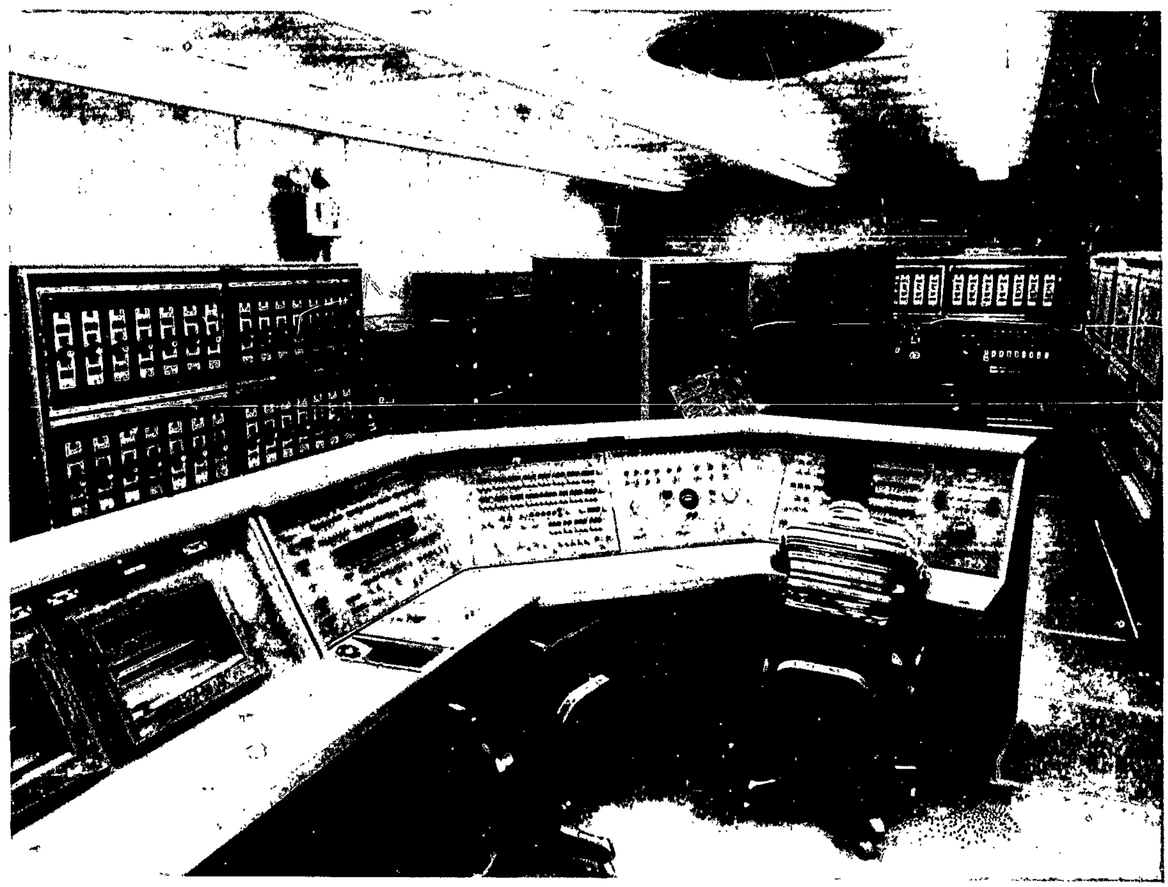


Photo by Burroughs Corporation

APPLICATIONS

The Model III Computer is a special purpose machine designed primarily for real time missile guidance. During the guidance operation, inputs to the computer come from a radar tracking system in the form of velocity and position information. Computed outputs (steering and discrete commands) are transmitted to the radar tracking system for ultimate action by the missile. The computers have been used in a real time range safety system for impact prediction, in addition to missile guidance. Although these are special purpose computers, their logical organization is similar to the general purpose scientific computer.

ARITHMETIC UNIT

Timing	Synchronous
Operation	Sequential

INPUT

Medium
- Tracking Radar
- Punched Mylar Tape

Tape is used for checking purposes

OUTPUT

Medium
- Missile Steering and Discrete Commands
- Punched Mylar Tape

Tape is used for checking purposes

CHECKING FEATURES

System includes automatic package and packet test equipment.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufactured in accordance with MIL-E-4158A and other Military Specifications.

BURROUGHS D107

Burroughs Model D-107

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System is used for general purpose computation, on line or off line.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	33 + 1 parity
Instruction/word	1
Instructions decoded	64
Arithmetic system	Fixed point
Instruction type	One address

Number range

Thirty three bits, with binary point at the left

Instruction word format

Tag	Com'd Type	Com'd Var.	Address First Modif	Address Second Modif	Register Address	Memory Address	Parity
1	2 - 5	6 - 9	10-12	13-15	16-19	20 - 33	34
1	4	4	3	3	4	14	1

Automatic coding will be available

There are 7 index registers

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec
Add	40
Mult	230 average
Div	426

Construction (Arithmetic unit only)

Transistors	2,750
Diodes	9,350
Registers	6,850
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Bits/Word	Access Microsec
Magnetic Core	4,096 to 16,384	34	0.2

Memory consists of non-destructive, random access, Fluxlok magnetic core. Read time is 0.2 microseconds. Write time (cycle-time) is 13.3 microseconds.

The Fluxlok memory provides a non destructive read feature which guarantees that the program or constants can not be lost due to transient errors.

Magnetic Tape 4 Units

Magnetic tape is not presently included in the system. Provisions are included for its additions.

INPUT

Media	Speed
Paper Tape	300 5-bit char/sec Photo reader
Keyboard	10 char/sec
Parallel Register	0.66 microsec transfer time for 34 bits
Serial Register	23 microsec transfer time for 34 bits

OUTPUT

Media	Speed
Paper Tape Punch	110 dig/sec
Parallel Register	0.66 microsec transfer time for 34 bits
Serial Register	23 microsec transfer time for 34 bits
Teletype Model 28	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	13,160
Transistors	3,470
Magnetic Cores	139,264

Figures are for a 4,096 word system

CHECKING FEATURES

Checking features include parity on all transfers

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1 Kw 1.1 KVA 0.9 pf
Volume, computer	6.75 cu ft
Area, computer	2.1 sq ft
Floor loading	120 lbs/sq ft
	80 lbs, concen. max
Weight, computer	240 lbs

The only requirement is the availability of a lighting type power outlet.

PRODUCTION RECORD

Time required for delivery from receipt of order
12 months

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

"Worst case" circuit design and construction in accordance with military specifications, plug in-subassemblies and Fluxlok memory all contribute to producing an extremely reliable computer design with a mean time between failures of 243 hours.

ADDITIONAL FEATURES AND REMARKS

Unique system advantages include non-destructive read on a random access memory.

BURROUGHS D 201

Burroughs D 201 (NADAC)

MANUFACTURER

Burroughs Corporation

APPLICATIONS

General purpose airborne computer designed to be used in a closed loop system with analog inputs and outputs for real time computations. It may be effectively used as a process control computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	21
Binary digits/instruction	14
Instructions/word	1
Instructions decoded	32 (20 presently used)
Arithmetic system	Fixed point
Instruction type	One address
Number range	19 bits plus sign (fractional)

Instruction word format

Operation	Address	Parity
7 - 11	12 - 19	20
5	8	1

Automatic built-in subroutines includes loading of drum from paper tape.

Registers

Input-Output Register, A Register (accumulator), B Register (Buffer), C Register (auxiliary register and extension of A Register), Operation Register, and Address Register.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	25	3
Mult	75	56
Div	75	68

Construction (Arithmetic unit only)

Transistors	4,761
Diodes	6,500
Magnetic Cores	135
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Drum	5,225	83,415	5,000
Magnetic Core	128	2,688	2.5

The computer proper has no tape units. However, provisions are made for use of one tape unit. This one channel has the capability of writing 10 binary digits plus sign every 25 microseconds.

INPUT

Media	Remarks
DC Voltage	± 2.000 volts full scale 32 input channels (multiplexed)
Code Wheel	18 (10 bit plus sign)

OUTPUT

Media	Remarks
DC Voltage	10 channels (multiplexed) ± 20 volts full scale
Digital to tape recorder	10 bit plus sign

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	6
Diodes	5,200
Transistors	6,600
Magnetic Cores	3,000

CHECKING FEATURES

Checking features include parity check, echo check on loading and diagnostic checks.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.9 Kw	400 cps
Power, air conditioner	0.25 Kw	400 cps
Volume, computer	6 cu ft	
Volume, air conditioner	2 cu ft	
Area, computer	3 sq ft	
Area, air conditioner	1 sq ft	
Floor loading	100 lbs/sq ft 300 lbs, concen max	
Weight, computer	300 lbs	
Weight, air conditioner	100 lbs	

Air conditioner is capable of dissipating 1,000 watts. No special site preparation required.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	10 months

PERSONNEL REQUIREMENTS

Training is made available by the Burroughs Corporation's Military Field Service Division.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Worst case design of all circuits insuring continuing operation with wide drift in parameters.

Extensive heat sinking because of high density packaging and lack of cooling air.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include D to A and A to D conversion at high accuracies and speed. Compact, fast and flexible for limited space requirement. Designed to meet MIL E 5400 Specifications.

BURROUGHS D 202

Airborne Bomb Navigation Computer D 202

MANUFACTURER

Burroughs Corporation

APPLICATIONS

The system is a general purpose airborne computer designed primarily for bombing and navigation computation. System is used in real time, on line.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	
Binary digits/instruction	
Instructions/word	1
Number of instructions decoded	36
Arithmetic system	Fixed point
Instruction type	One address
Number range	20 bits plus sign (fractional)

Instruction word format

Command	Address
1 - 5	6 - 14
5	9

Automatic built-in subroutines; include a load drum sub routine.

Registers include an A (accumulator), B (buffer), C (auxiliary register of A), Input-Output, Address, and a Command register.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	10	3
Mult	40	34
Div	80	73

Construction (Arithmetic unit only)

Transistors	3,000
Condenser-Diodes	18,000
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Drum	12,256	205,288	5,000
Ferrite Core	512	11,264	2

INPUT

Media	Speed	Remarks
Synchro	Continuously Addressable	3 wire servo
Code Wheels	Continuously Addressable	

OUTPUT

Media	Speed	Remarks
Synchro	Continuously Addressable	3 wire servo
DC voltage	Continuously Addressable	
Decimal Display	Continuously Addressable	

Computer is part of a closed loop system. As such inputs and outputs in many cases cannot be specifically specified.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Remarks
Diodes	12,000	Silicon
Transistors	5,000	Silicon

Components are all silicon to meet environment of $-55^{\circ}C$ to $+100^{\circ}C$.

CHECKING FEATURES

Checking features include parity and echo check on loading. Diagnostic checking can also be performed.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1.8 Kw
Volume, computer	4.3 cu ft
Area, computer	3.75 sq ft
Floor loading	50 lbs/sq ft
	220 lbs concen max
Weight, computer	220 lbs

No special site preparation requirements.

PRODUCTION RECORD

Number in current production	1
Number on order	1
Time required for delivery	12 months

Machine presently in final stages of test.

PERSONNEL REQUIREMENTS

Training is made available by the Burroughs Corporation, Military Field Service Division.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability includes potted sub assemblies (logi mods) for improved heat dissipation and ease of replacement, all silicon components, and worst case circuit design to insure operation with change in circuit parameters.

System utilizes a unique side entry connector with much higher pin pressure and is designed to MIL E-5400.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include high speed, capacity and flexibility for extremely small size.

Unique system advantages include a variety of inputs and outputs, extreme temperature tolerance, and input-output built on spearate unit to easily modify for other applications.

BURROUGHS D 203

Burroughs Model D 203

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System is used for special purpose, small scale, computation and process control.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	24
Binary digits/instruction	26
Instructions/word	1 arithmetic plus 2 memory transfer
Number of instructions decoded	9
Arithmetic system	Fixed point fractional binary
Instruction type	One operand address plus four memory transfer addresses plus next instruction address
Number range	$-2^{-23} + 1$ to $+2^{-23} - 1$

Instruction word format

0 - 9	10 - 15	16 - 19	20 - 25
Memory Control	Op Address	Operation	Next Inst. Address

Registers include an accumulator, multiplier, distribution, instruction, and 2 Buffer Registers.

By means of preselecting operands and placing them in fast access loops, (re memory transfer control above) access time problems are eliminated.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	86	86
Mult	3,000	3,000
Div	3,000	3,000

Construction (Arithmetic unit only)

Transistors	2,400
Diodes	2,800
Resistors	4,900
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Bin Dig	Access Microsec
Magnetic Drum	5,000	160,000	av. 2500
Fast Access loops	14	448	

Minor modifications allow addition of magnetic tape units

INPUT

Media	Speed	
Serial digital	2 words/200 microsec	24 bits
Parallel digital	1 word/200 microsec	24 bits
13 bit synchro inputs	continuous	
10 Discrete inputs	Relay closures	

OUTPUT

Media	Speed	
Six Synchro Outputs	continuous	19 bits
Eleven 400 Cycle Voltage	continuous	13 bits
Serial Digital	1 word/200 microsec	24 bits
Parallel Digital	1 word/200 microsec	24 bits

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
T6G	6,900
Transistors	
2N404	6,500
Resistors	10,000

CHECKING FEATURES

Diagnostic routine

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.860 Kw	860 KVA	1.0 pf
Volume, computer	15 cu ft		
Area, computer	10 sq ft		
Floor loading	200 lbs/sq ft		
Weight, computer	600 lbs		

Forced air cooling included

ADDITIONAL FEATURES AND REMARKS

Outstanding features include highly accurate analogue output and continuous updating of analogue outputs by means of incremental computing unit.

Unique system advantages include complete solution of access time problems associated with drum by means of novel memory transfer system. System provides highly accurate digital element for essentially analogue systems.

BURROUGHS D 204

Burroughs Submarine Computer Model D 204

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System can be used as a general purpose, solid state, fractional binary, signed magnitude computer. It is currently utilized for stabilization of submarine periscope and radiometric sextant in on-line, real time applications. It has a non-destructive program and constants memory of the linear select Random Access Memory (RAM) type. A-D and D-A conversions, utilizing automatic 10 KC extrapolation, are included.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	29 including sign and parity
Binary digits/instruction	17 including parity
Arithmetic system	Fixed point
Instruction type	One address
Number range	Fractional 0 - 1.0

Instruction word format

Operation	Address	Parity
5	11	1

Automatic built-in subroutines include square root, multiply, division, shift right and left, gray code conversion, real time clock operation, sub routine entry and return.

Automatic coding includes the IBM 704 computer simulator.

Registers

Accumulator	25 bit encoded register
Buffer register	Input-Output register
Program counter	6 Increment register
Address register	8 Total registers
Multiple Quotient register	Operation register
Shift register	Real Time register

There are approximately 40 holding flip flops used for control.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	10.2 - 12.6	2.0
Mult	30 - 108	25 - 100
Div	108	100

Construction (Arithmetic unit only)

Transistors	3360 (2N269, L5129, GA533242 and others)
Condenser-Diodes	8400 (Diodes-T6G and others, capacitors are mostly fixed with porcelain dielectric)
Magnetic -Cores	34,000
Other elements	12,000 (primarily resistors)
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Concurrent

System is asynchronous in that operations are completed in varying times, concurrent in that main arithmetic solutions are concurrent with incremental output updating.

STORAGE

Media	No. of Words	No. of Digits
Magnetic Core		
Wired core program	1,536	17
Wired core constants	128	29
Random Access Memory (Linear Select)	128	29

INPUT

Media	Speed Microsec	Remarks
Analog to Digital	10.2	3 bit auto shift conversion
Digital	10.2	Maximum 25 bits, serial, parallel operation
Optical Encoder	6.5	3 multiplex 23 bit parallel inputs speed is limited by optical encoder
Manual Switches		25 bits of coded digital, parallel automatically addressed

Computer contains serial-parallel input-output Register also contains automatic interrupt and start from outside control as a function of data transmission.

Computer has analog to digital converters, optical encoder code wheel inputs, gray code converter, digital input and outputs, six incremental and total extrapolators, 8 channels of digital to analog 10 KC converters, and manual switch inputs.

OUTPUT

Media	Speed Microsec	Remarks
Analog	50	10 KC Converter
Digital	10.2	25 bits parallel - serial

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
TGG	9,890
1N658	130
SG-22	520
Other	550
Transistors	
2N269	1,980
L5129	4,670
2N584	600
Other	1,250
Magnetic Cores	34,000

Includes cores for RAM and program and constants memories.

CHECKING FEATURES

System has parity, overflow and incrementing overflow, and self confidence checking features. Analog to digital null meter and displacement checks are made. Diagnostic program utilizing card reader, analog output voltage or difference checks can be made. Computer contains signals to indicate above

mentioned errors with manual and automatic reset controls.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1.87 Kw	2.18 KVA	.86 pf
Volume, computer	22.6 cu ft		
Area, computer	4.2 sq ft		
Floor loading	552 lbs/sq ft		
	1,160 lbs concen max		

Computer has been designed to operate in ambient of 75 ± 10°F

Weight, computer 1,160 lbs

System utilizes 2 kilowatts of 400 cycle, 3-phase power and 200 watts of 60 cycle, single-phase power.

PRODUCTION RECORD

Number produced to date	5
Number in current operation	4
Number in current production	5
Number on order	5
Anticipated production rates	one per month
Time required for delivery	7 months

COST, PRICE AND RENTAL RATES

Approximately $160,000 depending on quantity.

PERSONNEL REQUIREMENTS

One technician is required for each 8-hour shift.

Burroughs has provided formal training to naval personnel in operation and maintenance of the SDC. Installation, operation and maintenance personnel can be provided as required.

Computer is designed to operate automatically in real time applications. Operator is required only for turn-on, and turn-off, and to insert data into machine in the event of failure of associated equipments.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Machine essentially satisfies requirements of MIL-I-983B.

Mean time between failures has been calculated to be above 88 hours and appears to be validated by limited field experience.

Worst-cast design philosophy has been used throughout.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include self checking feature, extrapolators, 10 KC digital-analog converters, 8 parallel channels, card reader testing, easily modified for other uses, and easily programmed.

Unique system advantages include word length, speed of operation, input-output accessability, ease of maintenance, and over-under voltage regulation.

FUTURE PLANS

Because of its high computation speed, modifications are planned to extend the function of the machine in its present application. Modifications will include substitution of an 8192, 20 bit word electrically alterable program memory, and a 512 word, 29 bit electrically alterable constants memory for the wired core memories currently used, and increasing the working (RAM) memory to 512 words. Logic changes are to be incorporated which will increase the ease and speed of programming, and will allow operation with additional inputs and outputs on a time shared basis.

INSTALLATIONS

Two machines have been installed and are operating on submarines. Two machines are ready for installation.

BURROUGHS D 208

Burroughs Model D 208

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System is suitable for small scale special purpose computing, process control, and missile guidance.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	24
Binary digits/instruction	16
Instructions/word	1
Number of instructions decoded	13
Arithmetic system	Fixed point fractional
Instruction type	One address
Number range	$-(1 - 2^{-23})$ to $(1 - 2^{-23})$

Instruction word format

Operation	Index Bits	Address	Parity
1 - 3	5-6	7 - 15	16
4	2	9	1

Registers include 3 arithmetic registers, 1 Shift Counter, and two 6 bit "orring" index registers.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	26	26
Mult	700	700
Div	750	750

Construction (Arithmetic unit only)

Transistors	1,100
Condenser-Diodes	4,750
Resisters	1,850
Inductances	230
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Non-destructive Ferrite Core Memory	512	8,192	2
Non-destructive Ferrite Core Memory	192	4,608	2
Destructive Ferrite Core Memory	64	1,536	2

Although tape units are not presently associated with the design, minor modifications could allow addition of such equipment.

INPUT

Media

Five D.C. voltages with continuous conversion up to 13 bits

Four parallel digital inputs up to 24 bits
 Capacity exists for 256 input channels

OUTPUT

Media

Seven D. C. voltages, continuous, with 13 bits precision

Fifteen Relay inputs

Four parallel digital outputs, up to 24 bits
 Capacity exists for 256 output channels

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	7,000
Radio Recepter Type DP834 and DP835	
Transistors	1,820
Philco Type 2N496 and Fairchild Type 2N697	
Magnetic Cores	14,436
30-50 mil cores	
Resistors	3,250
Capacitors	1,150
Inductances	420

Packaged in Burroughs Logi-Mod Technique

CHECKING FEATURES

Parity and diagnostic checking techniques are used.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.225 Kw
Volume, computer	0.52 cu ft
Area, computer	3 sq ft
Weight, computer	33 lbs

Although some cooling is required, no special air conditioning facilities are necessary.

PRODUCTION RECORD

Time required for delivery 18 months

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by the manufacturer to insure required reliability include completely modular construction. All components are encapsulated to Logi Mods to withstand shock, vibrations, and high temperature gradients. Support structure provides heat removal. Cooling is provided by air flow through structure. All semiconductors are silicon.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include compactness, high performance, suitability for general purpose applications, and minimum cooling requirements.

BURROUGHS D 209

Burroughs Digital Differential Analyzer
(MADDAM) D 209

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System is a small DDA using advanced packaging techniques. It may be used in a real time control system, specifically missile born guidance system. It may be defined as a high speed serial 16 integrator DDA using a non-destructive read core memory. System has been referred to as MADDAM.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	16
Binary digits/instruction	32
Instructions per word	1/2
Instructions decoded	16
Arithmetic system	Fixed point

Twos complement arithmetic is performed at binary rates.

Masks are used to select integrator inputs

Two one-word masks are used to select precessing dz's.

Number range $1 - 2^{-14}$ to -1

There is one memory buffer register. Standard DDA organization of controls are used, with the memory acting like a drum.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec
Add	32 integrator

Construction (Arithmetic unit only)

Transistors	250
Condensers	1,000
Resistors	350
Capacitors	150
Inductors	60
Arithmetic mode	Serial

STORAGE

Media	No. of Words	Access Microsec
Non-destructive Read Magnetic Core	48	0.5
Destructive Read Magnetic Core	33	0.5

INPUT

Media
Analogue
Delta modulation conversion to digital

OUTPUT

Medium
Analogue
Delta de-modulation conversion from digital

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
PD202-P.S.I.	1,626
Transistors	700
2N718	
2N706	
Fairchild	
Magnetic Cores	1,296

CHECKING FEATURES

Parity checking and error recovery

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	Battery operated
Volume, computer	0.1 cu ft
Area, computer	0.3 sq ft

System is desk size
Heat sinks in frame preclude need for air conditioner

Weight, computer	12 lbs

Battery operation precludes need for site preparation

PRODUCTION RECORD

Number produced to date	1
Number in current production	several/month
Anticipated production rates	10/month

PERSONNEL REQUIREMENTS

Computer programs for special purposes are supplied.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Reliability is achieved by macro-module construction, Fluxlok permanent memory and HTDL logic. First unit was completed in October 1960.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include the fact that this extremely small, fast DDA can be used in missile systems.

Unique system advantages include advanced packaging techniques and Fluxlok memory.

System operates up to 125°C at 100% humidity.

Machine memory is expandable if desired.

BURROUGHS E 101

Burroughs Model E 101 Electronic Digital Computer

MANUFACTURER

Burroughs Corporation

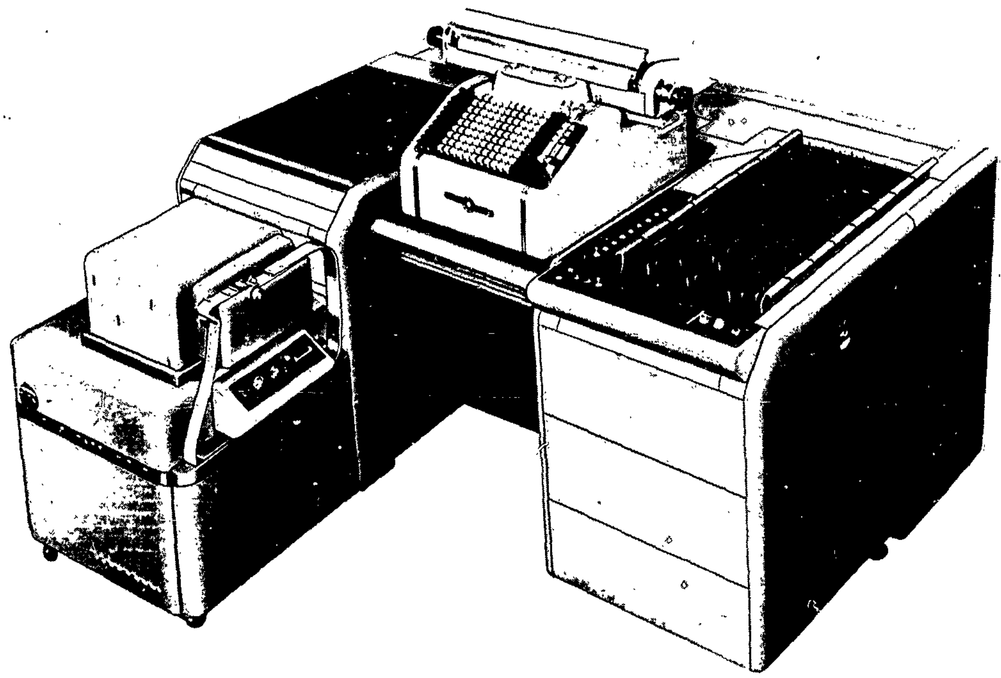


Photo by the Burroughs Corporation

APPLICATIONS

Manufacturer
Scientific and business

U. S. A. Corps of Engineers, Cincinnati
Located in Room 450, 315 S. Main Street, Cincinnati, Ohio, the system is used for Hydrology, Hydraulics, and Statistics.

U. S. A. Corps of Engineers, Huntington
Located at 502 Eighth Street, Huntington, West Virginia, the system is used for Hydrology, Hydraulics, Statistics, and Structures.

U. S. A. Corps of Engineers, Philadelphia
Located at Operations Division, U. S. Army Engineer District, Philadelphia, the system is used for Dredging Quantities, Survey Traverse Closure Adjustments, Sextant Chart Layout, Reservoir Operations, Back water Profile (subcritical) including overbank flow, Cross Sectional Areas - Beach Profile, Deviation, Mean and Skew Computation on Concrete Samples, Quantity Take-off for Earthfill Dam, and Payroll Computation and Distribution.

U. S. A. Corps of Engineer, Tulsa
Located at Tulsa, Oklahoma, the system is used for Hydraulic, Hydrologic, Civil Engineering and Payroll Computations.

U. S. A. Corps of Engineers, Washington
Located at 1st & Douglas Streets, N. W., Washington D. C., the system is used for Hydraulics & Hydrology (Engineering), Statistics (Engineering), Structural Design (Engineering), and Cost Distribution (Accounting).

NATC, Patuxent River
Located at Armament Test, the system is used for problems previously done on desk calculators, and preliminary calculation required on larger problems prior to entry into the Burroughs 205.

City & County of San Francisco
Located at City Hall, system is used by the Department of Public Works.

Automobile Carriers, Inc.
System is used to prepare daily billing, compute payroll data, and to compile mileage and tonnage statistics.

Burroughs Military Electronic Computer Division
Located at the Military Electronic Computer Division, 14300 Tireman, Detroit 28, the system is used for the generation of SAGE AN/FST-2 performance parameters such as Availability, Reliability, Maintainability, and Mean-time-between-failures; for the SAGE AN/FST-2 critical part and assembly removal rate analysis: Units that were removed at an excessive rate during a given period are determined and listed; and for miscellaneous tabulations, such as Public Voucher Accounting tabulations listing total expenditures on a given contract by account number for material, labor, burden, % G&A, etc.

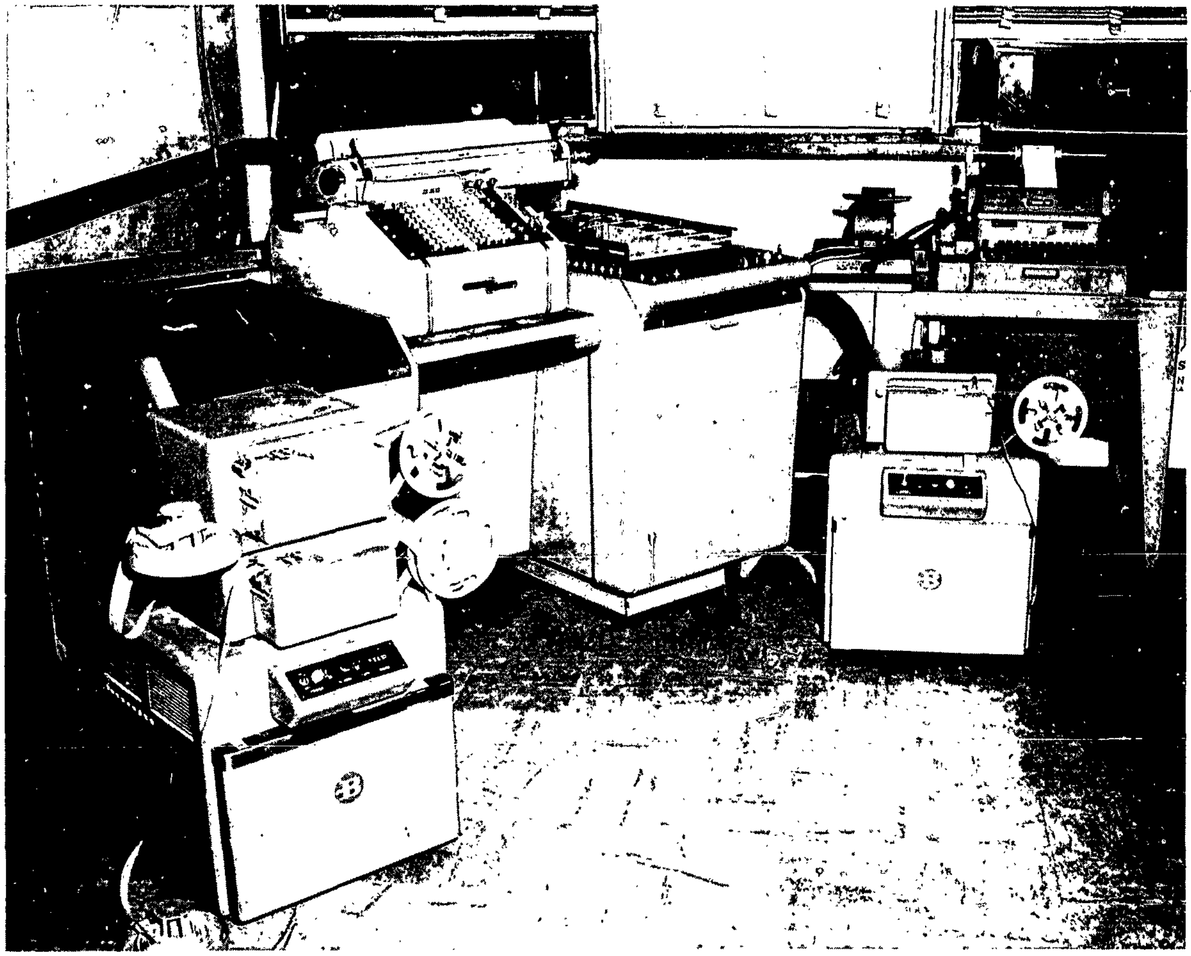


Photo by U. S. Army Corps of Engineers

Hudson Engineering Corporation
Located at 5900 Hillcroft, Houston, Texas, the system is used for process design calculation, structural design, and pipeline design.

Morgan Guaranty Trust Company of New York
Located at 140 Broadway, New York 15, N. Y., the system is used for loan bookkeeping.

United States Rubber Company Research Center
Located at U. S. Rubber Company Research Center, Alps Road, Wayne, New Jersey, the system is used for maximization of polynomials representing rubber properties, evaluation of theoretical functions over wide ranges, contour plotting of polynomials, correlation and regression analysis, curve fitting, real and complex roots of polynomials, and solutions to special functions.

ZOOMAR Inc.
Located at Zoomar Inc., 55 Sea Cliff Avenue, Glen Cove, N. Y., system is used for optical design calculations, especially ray tracing.

Bucknell University
Located at the Engineering Building, system is used for education at all levels.

Colorado State University
Located at Colorado State University, the system is used for statistical analysis and for training in computer operating and programming.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal
Decimal digits/word	12 + sign
Decimal digits/instruction	3
Instructions per word	1
Instructions decoded	27
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-10\ (1-10^{-11}) \leq n \leq +10\ (1-10^{11})$

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec
Add	50,000
Mult	250,000
Div	250,000

Construction (Arithmetic unit only)
Constructed of vacuum tubes and diodes

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	220	2,640	8,500
Paper Tape			
Punch Cards			

External pinboard programming, 128 program steps.
Drum makes one rotation in 16.9 milliseconds.

INPUT

Manufacturer

Media	Speed
Keyboard	Manual
Paper Tape	0.5 sec to read
Cards	20 char/sec

U. S. A. Corps of Engineers, Philadelphia

11 column Keyboard	24 char/sec
Sensimatic Model F-1	
Punched Paper Tape Input, Model A531	20 char/sec
8 channel tape	
Duplex Paper Tape Input, Model A532	20 char/sec
8 channel tape	

Duplex Unit permits reading of two input tapes alternately and provides program extension.

U. S. A. Corps of Engineers, Tulsa

Keyboard	533 Milliseconds
Paper Tape	50D + 133 Milliseconds, where D = Number of digits.

U. S. A. Corps of Engineers, Washington

Punched Paper Tape	20 char/sec
11 Digit Keyboard	

NATC, Patuxent River

Keyboard	Manual
Paper Tape	0.5 sec to read

The Tape Input Unit, Model A531, is capable of accepting a seven channel punched paper data tape prepared in the Burroughs 204 code or standard E101-3 code. Choice is made with an externally mounted, manually operated switch. Entries regarding input are from manufacturer's specifications.

Automobile Carriers, Inc.

Keyboard	7 char/sec, plus sign
Paper Tape	20 char/sec, plus sign

Burroughs Military Electronic Computer Division

Card (A536)	17 digits/sec
Keyboard	

Not suitable for data reduction programs for large quantity of input. Adequate for wide range of application in research, design, and business.

ZOOMAR Inc.

Media	Speed
Full 11 Column Keyboard	
Paper Tape (Duplex)	20 char/sec

2 reading heads permit simultaneously use of 2 program-or data-tapes. Instructions are executed directly from tape and therefore do not require storage space.

Colorado State University

Cards	20 char/sec

OUTPUT

Manufacturer

Media	Speed	
Printer (Sensimatic)	24 digits/sec	
Paper Tape	0.33 secs to punch	Buffered
Punch Card	20 char/sec	Buffered

U. S. A. Corps of Engineers, Huntington

Printer	24 dec dig/sec
Paper Tape	600 dec dig/min

NATC, Patuxent River

The Tape Punch, Model A516, is capable of preparing a data tape in the seven channel Burroughs 204 code in addition to punching a program or data tape in E101-3 code.

Automobile Carriers Inc.

Posting Machine	20 char/sec
Paper Tape	10 char/sec (For data)
	13 char/sec (For instructions)

ZOOMAR Inc.

Printer (ganged)	Two 12-digit words/sec
Tape Punch	20 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity
Tubes	160
Diodes	1,800

CHECKING FEATURES

Manufacturer

Checking features include plug-in circuitry, marginal voltage checking, internal program checking, parity check on paper tape input and output, and automatic error detection in printing circuits.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	3 Kw
Room size	Desk size
Weight, computer	1,800 lbs

U. S. A. Corps of Engineers, Cincinnati

Power, computer	3 Kw
Volume, computer	60 cu ft
Area, computer	20 sq ft

U. S. A. Corps of Engineers, Huntington

Room size	10.5 Ft x 19.0 ft

U. S. A. Corps of Engineers, Philadelphia

Enclosed 12 1/2 ft x 16 ft space and extended existing power service to provide 2 - 220 volt service lines in room.

U. S. A. Corps of Engineers, Tulsa
Capacity, air conditioner 2 Tons
Air conditioner 2 one-ton window units
Ran 220 volt line for computer and air conditioners.

U. S. A. Corps of Engineers, Washington
Floor loading 110 lbs/sq ft
400 lbs concen max
Does not require air conditioning in excess of normal office air conditioning.

NATC, Patuxent River
The E101-3 was installed in a room 16.5 ft x 39 ft already housing some data reduction equipment. The floor was reinforced to meet load requirements. Existing air conditioning was adequate to absorb E101-3 heat generated, therefore existing air conditioner is used.

Automobile Carriers Inc.
Room size 12 ft x 12 ft minimum
115-230 volt 3 wire single phase plus a ground wire. Terminate line in a 2 pole 20 amp circuit breaker. For small room, 2 window air conditioning units are recommended.

Burroughs Military Electronic Computer Division
Voltage: 230V, three phase, 115V three phase power line, 25 amps. 6 seven inch fans are used for ventilation.

Hudson Engineering Corporation
Acoustical treatment of walls, ceiling and floor.
Exhaust ducts and hoods to remove air directly from machines.
Two tons of air conditioning was added to central unit.

U. S. Rubber Company Research Center
Floor loading 67 lbs/sq ft

ZOOMAR Inc.
Room size 10 ft x 10 ft minimum
220V single phase special power line.

Bucknell University
Air conditioner Window size

Colorado State University
Floor loading 20 lbs/sq ft
500 lbs concen max

PRODUCTION RECORD

Manufacturer

Number in current operation	127
Time required for delivery	4 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Cost	Monthly Rental
Basic System	$29,750	$875
Computer, Model E-101. (Includes Magnetic Drum Memory of 220 words of 12 digits each, 16 removable pinboards for external programming (eight pinboards may be used with the E-101 at one time) and Keyboard Printer with 11-column keyboard for input, and 12 digit + sign output		
Additional equipment		
Punched Paper Tape Input	2,950	85
Punched Paper Tape Output	2,950	85
Punched Card Input	3,450	105
Punched Card Output	2,375	70

Preventive maintenance is performed monthly by the Burroughs engineers, other service is on an "ON-CALL" basis.

U. S. A. Corps of Engineers, Cincinnati
Basic system
G. S. A. Contract $1,000/month.
Additional equipment
G. S. A. Contract Tape Input $100/month.
Maintenance/service contracting is included in the rental.

U. S. A. Corps of Engineers, Philadelphia

	Cost	Monthly Rental
Computer, Model E-101	$38,325	$1,000
Punched Paper Tape Input, Model A531	3,765	100
Duplex Paper Tape Input, Model A532	2,375	65

Maintenance/service contracting is included in monthly rental; $2,600 is paid annually on purchased equipment.

U. S. A. Corps of Engineers, Tulsa
Flexowriter cost $2,623.50.
E-101 Computer rents at $1,000 per month.
Tape Input Unit rents at $165 per month and Tape Output Unit rents at $100 per month.
Flexowriter service is $150 per year.

NATC, Patuxent River
1 E101-3 Computer, 1 Punched Paper Tape Input Unit, Model A531, and 1 Punched Paper Tape Output Unit, Model A516 cost $33,100.

Automobile Carriers Inc.
Rental rate for basic system is $875 per month.
Rental rates for additional equipment per month

Tape Input	$100
Tape Outputs	100
Additional pinboards	50

Burroughs Military Electronic Computer Division
The E 101-3, A536, and A516 is rented at $1,300 per month.

Hudson Engineering Corporation
Two of the following systems were purchased:

Computer	$30,000
Tape Input	2,500
Tape Output	3,500

A Flexowriter was purchased at $2,500.
Maintenance/service is $2,500/year on each system.

U. S. Rubber Company Research Center

Computer	$37,730
Tape Input Unit	6,810
Tape Output Unit	4,010
Additional Pinboard Units	360

Maintenance service at $2,780 per annum.

ZOOMAR Inc.
System cost $36,550.
Additional equipment rents at $3,480 per annum.
Maintenance service cost $2,400 per annum.

Colorado State University

Computer only, with educational discount	$30,000
Cost of input	2,500
IBM-EAM	220/mo.
Burrough Service Contract	$2,400/year.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift
Programmers	1
Operators	1
Engineers	1

Programming and operating instructions will be given at no cost to the customer either at his installation or at the manufacturer's facilities.

U. S. A. Corps of Engineers, Cincinnati

One part time supervisor and one operator.
Operation tends toward open shop.
Manufacturer's training is used.

U. S. A. Corps of Engineers, Huntington

	One 8-Hour Shift	
Supervisors	1	part time
Programmers	1	part time
Operators	1	

Manufacturer's training is used.

U. S. A. Corps of Engineers, Philadelphia

	One 8-Hour Shift Used	Recommended
Programmers	1/2	1/2
Operators	1/2	1/2
In-Output Opera	1/2	1/2

Operation tends toward closed shop.
Classroom instruction by Burroughs Corporation in basic programming and operating techniques. On-the-job training for operators and programmers as required.

U. S. A. Corps of Engineers, Tulsa

	One 8-Hour Shift Used	Recommended	
Supervisors	1	1	part time
Operators	1	1	part time

Operation tends toward open shop.
Two day programming schools conducted by Burroughs Corporation are utilized.

U. S. A. Corps of Engineers, Washington

	One 8-Hour Shift Used	Recommended
Supervisors	1/4	1
Programmers	1/2	1
Engineers	1/2	1

Operation tends toward open shop.
Training accomplished by manufacturer at no cost.

NATC, Patuxent River

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Programmers	14	14

Operation tends toward open shop.
The training received by programmers is that which is available through the computer manufacturer. Programming is not a primary duty of mathematicians or mathematics aids.

Automobile Carriers Inc.

	One 8-Hour Shift
Programmers	1
Operators	1

Operation tends toward open shop.

Burroughs Military Electronic Computer Division

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	1	1
Clerks	1	1

Operation tends toward closed shop.
Classroom type grouped training is given.

Hudson Engineering Corporation

	One 8-Hour Shift
Supervisors	1
Programmers	1
Operators	2

Operation tends toward open shop.
On-the-job training is given.

U. S. Rubber Company Research Center

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	1

Operation tends toward closed shop.
Methods of training used include on-the-job training and partial tuition refund plan.

ZOOMAR Inc.

	One 8-Hour Shift
Analysts-Programmers	1
Operators	1

Operation tends towards closed shop.

Colorado State University

	One 8-Hour Shift Used	Recommended
Supervisors	1	
Analysts	1	4
Programmers	6	6
Coders	0	10
Clerks	2	2
Librarians	0	1
Operators	1	2
Engineers	1	1
Technicians	0	1

Operation tends toward open shop.
Methods of training used:
 Seminars for staff personnel
 Regular classes for students
 System is used for instruction in computer programming, coding, and operating.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

U. S. A. Corps of Engineers, Cincinnati

Good time 41 Hours/Week (Average)
Attempted to run time 42 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period from Apr 57 to Jun 60
Passed Customer Acceptance Test Nov 56
Time is available for rent to certain qualified outside organizations.

U. S. A. Corps of Engineers, Huntington

Good time 39 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) .0975
Above figures based on period from Feb 58 to Jun 60
Passed Customer Acceptance Test Feb 58
Time is not available for rent to outside organizations.

U. S. A. Corps of Engineers, Philadelphia

Average error-free running period 18 months
Operating ratio (Good/ Attempted to run time) 1.0
Above figures based on period 1 Jan 60 to 30 Jun 60
Passed Customer Acceptance Test 18 Jul 60
Time is available for rent to qualified outside organizations.

Information based on rental on a service bureau E-101 computer used exclusively by this organization. This organization has experienced only one occasion in 18 months of operation of service bureau machine wherein the E-101 made an undetected error. Time would be made available for rental to outside organizations on a second shift basis. Qualified opera-

tors would normally be expected to be provided by user.

U. S. A. Corps of Engineers, Tulsa

Average error-free running period 1 Week
Good time 34 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period 1 Feb 58 to 31 Jun 60
Passed Customer Acceptance Test L Feb 58
Time is not available for rent to outside organizations.

U. S. A. Corps of Engineers, Washington

Average error-free running period 1 Month
Good time 21 Hours/Week (Average)
Attempted to run time 22 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.96
Above figures based on period from Jun 58 to Jun 60
Passed Customer Acceptance Test 1 Jul 60
Time is available for rent to outside organizations.
Running time data based on E-101 installation.
Current system installed 1 July 1960.

NATC, Patuxent River

Operating experience is kept on a monthly basis. The figures below are monthly averages:

Production	54.1
Program Checking	13.8
Idle	72.9
Down	11.6

Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test Aug 59

Automobile Carriers Inc.

Good time 31 Hours/Week (Average)
Attempted to run time 33 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period 1 Aug 60 to 31 Aug 60
Time is available for rent to qualified outside organizations.

Burroughs Military Electronic Computer Division

Good time 35 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period from Jan 58 to Jan 59
Time is not available for rent to outside organizations.

Hudson Engineering Corporation

Operating ratio (Good/Attempted to run time) 0.90
Time is available for rent to qualified outside organizations.

Morgan Guaranty Trust Company of New York

Time is not available for rent to outside organizations.

U. S. Rubber Company Research Center

Good time 21.4 Hours/Week (Average)
Attempted to run time 23.1 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.926
Above figures based on period 1 Oct 59 to 1 Jul 60
Passed Customer Acceptance Test Dec 57
Time is not available for rent to outside organizations.

ZOOMAR Inc.

Good time 32 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.80
Above figures based on period 1 Jan to 31 Jul
Time is not available for rent to outside organizations.

Bucknell University

Operating ratio (Good/Attempted to run time) 0.8
Passed Customer Acceptance Test Jul 58
Time is available for rent to qualified outside organizations.

Colorado State University

Good time 15 Hours/Week (Average)
Attempted to run time 18 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.833
Above figures based on period from Aug 58 to Apr 60
Passed Customer Acceptance Test Aug 58
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Card output adapter permits connection of a keypunch to enable output data only from the computer accumulator. The multiple input adapter enables the simultaneous connection of a punch paper tape input and a punch card input, a duplex paper tape input and a punched card input or a duplex paper tape input and a second paper tape input.
Unique system advantages include ease of programming and complete formatting ability with the Burroughs Sensimatic Printer.

U. S. A. Corps of Engineers, Huntington

Outstanding features include ease of programming.

U. S. A. Corps of Engineers, Philadelphia

Outstanding features are operating flexibility - automatic or operator intervention, external pinboard programming permits program modification or alteration with minimum of delay, and automatic address modification by means of 2 counters for sequencing in repetitive operations. External pinboard programming is unique with the E-101; provides a means of quickly and easily modifying program based on intermediate results, experience and judgment.

U. S. A. Corps of Engineers, Washington

This machine is very easy to program and operate, thus enabling engineering personnel to program and run their own programs.

NATC, Patuxent River

Unique system advantages include tape input and output compatibility with other systems, such as semiautomatic film readers, Datatron 204, and electric plotter.

Burroughs Military Electronic Computer Division

Outstanding features include ease of operation. The system brings advantages of electronic computation into the area of small calculating problems.

U. S. Rubber Company Research Center

Outstanding features include programming simplicity and ease of operation.
Unique system advantages include rapid program development, which permits economical use of computer for many "one-shot" programs as well as standard routines.
Paper tape is stored in special loose-leaf binder.

ZOOMAR Inc

Outstanding features are ease of programming and operation. System can be operated like a desk calculator, but at much greater speed. Allows the economical handling of problems, usually not assignable to larger digital computers.

Colorado State University

An outstanding feature is its simplicity. It serves as an excellent training device.

FUTURE PLANS

U. S. A. Corps of Engineers, Huntington
We will expand to two shifts.

U. S. A. Corps of Engineers, Philadelphia
Plan to obtain Punched Paper Tape Output, Model A516 ($100/monthly lease) to be able to handle additional accounting applications.

NATC, Patuxent River
Purchase of a duplex paper tape input unit for use with the installed Model A531 Tape Input Unit. This will form a system whereby commands and data in E101-3 or Burroughs 204 code may be read alternately without changing tapes.

INSTALLATIONS

U. S. Army Chemical Center
Edgewood, Maryland

Army Ballistics Missile Agency
Redstone Arsenal
Huntsville, Alabama

Army Ballistic Missile Agency
Cape Canaveral, Florida

U. S. A. Corps of Engineers, Ohio River
315 -335 Main Street
Cincinnati, Ohio

U. S. A. Corps of Engineers, Huntington
502 8th Street
Huntington 1, West Virginia

U. S. A. Corps of Engineers, Philadelphia
2635 Abbottsford Avenue
Philadelphia 29, Pennsylvania

U. S. A. Corps of Engineers, Tulsa
Tulsa, Oklahoma

U. S. A. Corps of Engineers, Washington
First and Douglas Streets NW
Washington 25, D. C.

Frankford Arsenal
Philadelphia, Pennsylvania

White Sands Missile Range
New Mexico

Bureau of Yards and Docks
Washington, D. C.

Armament Test, NATC,
Patuxent River, Maryland

David Taylor Model Basin
Carderock, Maryland

U. S. Naval Research Laboratory
Vanguard Project
Cape Canaveral, Florida

Edwards Air Force Base
California

Wright Air Development Center
Wright-Patterson Air Force Base
Fairborn, Ohio

Defense Supply Service
Washington, D. C.

California Institute of Technology
Jet Propulsion Laboratories (NASA)
Pasadena, California

Space Technology Laboratories
Los Angeles, California

Department of Public Works
City and County of San Francisco, City Hall
San Francisco, California

Aerojet-General Corporation
Azusa, California

Beech Aircraft Corporation
Wichita, Kansas

Bell Helicopter Corporation
Fort Worth, Texas

Boeing Airplane Company
Flight Test Division
Seattle, Washington

Convair
San Diego, California

Douglas Aircraft Company
El Segundo, California

Fairchild Guided Missiles
Astrionics Division
Wyandauch, Long Island, New York

Hughes Aircraft Company
Culver City, California

McDonnell Aircraft Corporation
St. Louis, Missouri

North American Aviation
Los Angeles, California

Pratt and Whitney Aircraft
East Hartford, Connecticut

Federal Reserve Bank of Chicago
Chicago, Illinois

First National City Bank
New York City, New York

Morgan Guaranty Trust Company of New York
140 Broadway
New York 15, New York

Wachovia Bank and Trust Company
Winston-Salem, North Carolina

Aetna Life Insurance Company
Hartford, Connecticut

Colonial Life Insurance Company
East Orange, New Jersey

General Insurance Company of America
Seattle, Washington

Mutual Insurance Advisory Association
New York City, New York

Mutual Insurance Company of New York
New York City, New York

National Bureau of Casualty Underwriters
New York City, New York

The Travelers Insurance Company
Hartford, Connecticut

Ethyl Corporation
Detroit, Michigan

Humble Oil Company
Baytown, Texas

Standard Oil Company
Cleveland, Ohio

Sun Oil Company
Philadelphia, Pennsylvania

Alega Engineers Incorporated
Houston, Texas

All American Engineering Company
Wilmington, Delaware

American Research Corporation
Atlanta, Georgia

American Totalisator Company
Baltimore, Maryland

Automobile Carriers, Inc.
P. O. Box 128
Flint, Michigan

Burroughs Military Electronic Computer Division
14300 Tireman
Detroit 28, Michigan

Edgerton, Germeshausen and Grier, Inc.
Boston, Massachusetts

General Electric Company
Philadelphia, Pennsylvania

General Electric Company
Syracuse, New York

Hudson Engineering Corporation
5900 Hillcroft
Houston, Texas

Kollmorgen Optical Corporation
Northampton, Massachusetts

Minneapolis-Honeywell Regulator Company
Philadelphia, Pennsylvania

Morgan Construction Company
Worcester, Massachusetts

Olin Mathieson Chemical Corporation
New Haven, Connecticut

Paoli Research Center
Burroughs Corporation
Paoli, Pennsylvania

Praeger-Kavanagh Engineering
New York City, New York

Radio Corporation of America
Waltham, Massachusetts

Smith Kline and French Laboratories
Philadelphia, Pennsylvania

Tung - Sol Electric Incorporated
Newark, New Jersey

The Upjohn Company
Kalamazoo, Michigan

U. S. Rubber Company Research Center
Alps Road
Wayne, New Jersey

U. S. Steel Corporation
Monroeville, Pennsylvania

Ward Baking Company
Chicago, Illinois

Westinghouse Electric Corporation
Aviation Gas Turbine Division
Kansas City, Missouri

Westinghouse Electric Corporation
Sharon, Pennsylvania

ZOOMAR Incorporated
55 Sea Cliff Avenue
Glen Cove, Long Island, New York

Bucknell University
Lewisburg, Pennsylvania

Colorado State University
Computing Center
Fort Collins, Colorado

Georgetown University
Washington, D. C.

Institute of Textile Technology
Charlottesville, Virginia

Massachusetts Institute of Technology
Cambridge, Massachusetts

New York University
New York City, New York

Syracuse University
Syracuse, New York

University of Cincinnati
Cincinnati, Ohio

University of Detroit
Detroit, Michigan

University of Missouri
Columbia, Missouri

University of Pennsylvania
Philadelphia, Pennsylvania

BURROUGHS E 102

Burroughs Model E 102 Electronic Digital Computer

MANUFACTURER

Burroughs Corporation

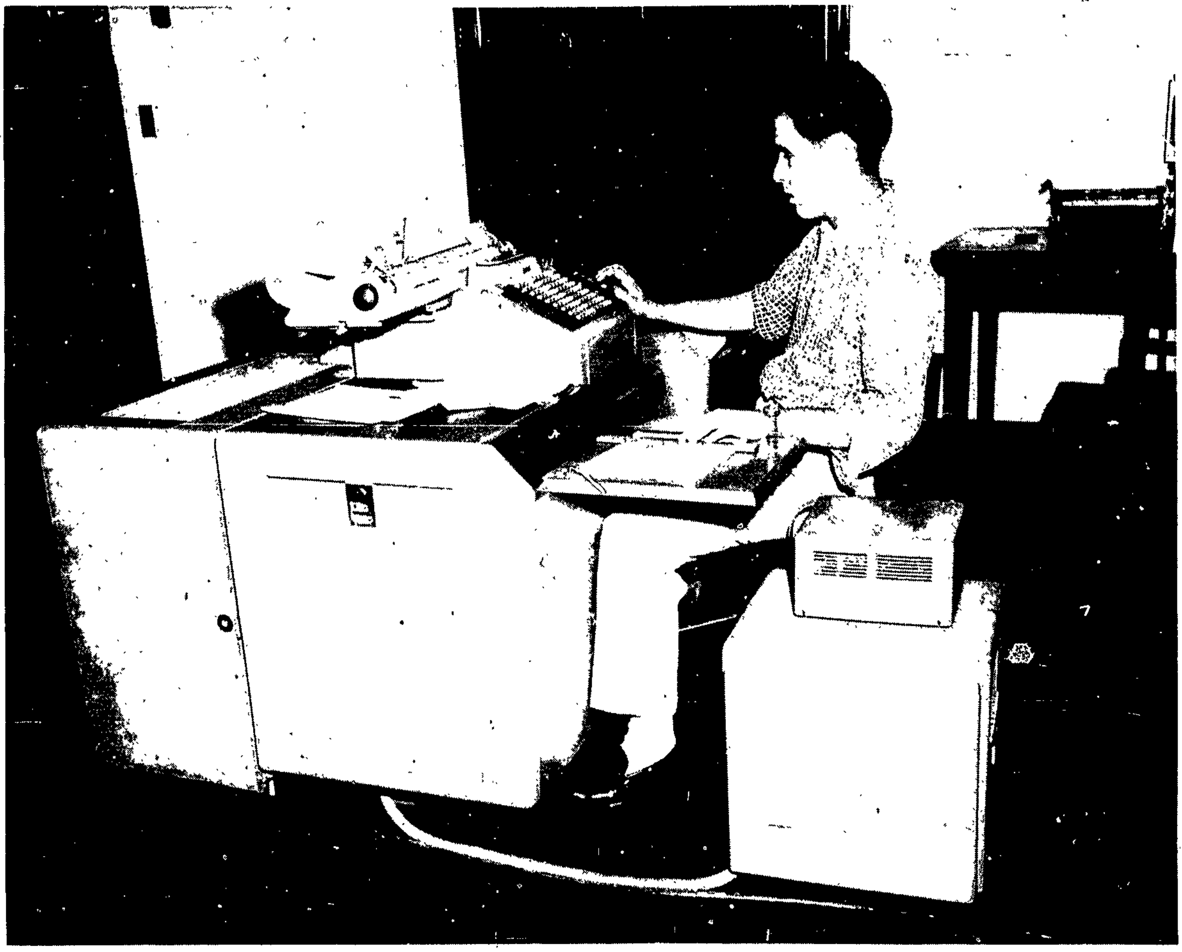


Photo by U. S. Army Engineer District, Kansas City

APPLICATIONS

Manufacturer
Scientific and business. System is similar to the BURROUGHS E 101.

U. S. Army Engineer District, Kansas City
Located on the Mezz. Floor, Federal Office Building, Kansas City 6, Missouri, the system is used for engineering, mathematical and scientific applications, including structural analysis and design, hydraulic and hydrological studies, soils, earthwork and dredging, and topography and geodetics.

Burroughs Corporation
Located at the Burroughs Corporation, Military Electronic Computer Division, 14300 Tireman, Detroit 28, Michigan, the system is used for the generation of SAGE AN/FST-2 performance parameters such as availability, reliability, maintainability, and mean-time-between-failures; for the SAGE AN/FST-2 critical part and assembly removal rate analysis. Units that were removed at an excessive rate during a given period are determined and listed; and for miscellaneous tabulations such as public voucher accounting tabulations listing total expenditures on a given contract by account number for material, labor, burden, % G and A, etc.

Burroughs Corporation
Located at the Burroughs Corporation, Methods and Procedures Division, 6071 Second Avenue, Detroit 32, Michigan, the system is used for inventory extension, sales quota calculation, master card part cost extension, and miscellaneous engineering design problems.

Edgerton, Germeshausen & Grier, Inc.
Located at 160 Brookline Avenue, Boston, Mass., the system is used for photogrammetric data processing (triangulations, dimensional measurements), statistical calculations (correlation coefficients, least squares curve fitting, etc.), and occasional business statistical uses.

Photo by Edgerton, Germeshausen & Grier, Incorporated

Space Technology Laboratories, Inc.
Located at the Computation and Data Reduction Center, 2400 E. El Segundo Blvd., El Segundo, California, the system is used for small scale scientific computations.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	12 + sign
Decimal digits/instruction	3
Instructions/word	1
Instructions decoded	27
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-10\ (1-10^{-11}) \leq n \leq +10\ (1-10^{11})$

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	50,000
Mult	250,000
Div	250,000

Construction (Arithmetic unit only)
Constructed of vacuum tubes and diodes

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No of Words	No. of Digits	Access Microsec
Magnetic Drum	220	2,640	8,500
Paper Tape			
Punch Cards			

External pinboard programming, 128 program steps. Drum makes one rotation in 16.9 milliseconds.

All of the above five reporting users utilize the 220 word magnetic drum memory.

INPUT

Manufacturer

Media	Speed
Keyboard	Manual
Paper Tape	0.5 sec. to read
Card	20 char/sec

All of the five reporting users utilize the 11 column keyboard and punched paper tape input.

OUTPUT

Manufacturer

Media	Speed
Printer (Sensimatic)	24 digits/sec
Paper Tape	0.33 secs to punch Buffered
Punch Card	20 char/sec Buffered

All of the five reporting users utilize the Sensimatic Printer.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	160
Diodes	1,800

CHECKING FEATURES

Checking features include plug-in circuitry, marginal voltage checking, internal program checking, parity check on paper tape input and output, and automatic error detection in printing circuits.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	3 Kw
Room size, computer	Desk Size
Weight, computer	1,800 lbs

USAD, Kansas City

Power, computer	3.0 Kw	3.0 KVA	1.0 pf
Volume, computer		50 cu ft	
Area, computer		17 sq ft	
Room size, computer		18 ft x 23 ft	
Floor loading		82.5 lbs/sq ft	
		1,400 lbs concen max	
Weight, computer		1,400 lbs	

Basically the only site preparation was the installation of an adequate power supply. (115-230 volt, 3-wire, single-phase circuit) If building air conditioning is not available, about 1 1/2 tons would be required for the space utilized.

Burroughs Corp., 14300 Tireman

Power, computer	2.8-5.7 KVA
Volume, computer	Desk Size
Area, computer	100 sq ft
Room size, computer	144 sq ft

Voltage: 230 three-phase, 115 three-phase; 25 amps. No installation preparations other than electrical power line. Six 7 inch fans.

Burroughs Corp.

Power, computer	2.8-5.7 KVA
Area, computer	100 sq ft
Room size, computer	144 sq ft

No installation preparations other than electrical power line. Six 7 inch fans.

E, G & G, Inc.

Power, computer	3.5 Kw
Area, computer	20 sq ft
Room size, computer	12 ft x 12 ft

Computer generates 12,000 BTU. We have no special air conditioner. The computer is located in standard air conditioned environment. No special building modifications. Installation of power cable required; 115 230 volt, 3 wire single phase plus ground.

STL

Power, computer	2.5 KVA
Volume, computer	1,500 cu ft
Area, computer	150 sq ft
Floor loading	80 lbs/sq ft

Air conditioner is included in house system. No special site preparation required.

PRODUCTION RECORD

Number in current operation	127
Time required for delivery	4 months

COST, PRICE AND RENTAL RATES

USAD, Kansas City

E-102 Computer rents at $1,000/month.

Model A531 Punched Paper Tape Input Unit rents for $100/month.

Maintenance is furnished along with the basic rental price of the system.

Burroughs Corp., 14300 Tireman

The E-102 and A531 rents at $1,175/month.

Burroughs Corp.

The E-102 and A531 purchase cost was $42,090.

E, G & G, Inc.

The E-102 cost $30,000.

The tape input unit cost $10,000.

No contract - service as required.

STL

System cost $28,000 and rents at $1,100/month. Service is included in rental.

PERSONNEL REQUIREMENTS

Manufacturer

	Each 8-Hour Shift
Programmer	1
Operator	1
Engineer	1

Programming and operating instructions will be given at no cost to the customer either at his installation or at the manufacturer's facilities.

USAD, Kansas City

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Programmers	1	2
Clerks	1	1

The supervisor is also a programmer.

Operation tends toward open shop. The installation is operated as an "open shop" with "closed shop" programming assistance as required. The semi-open shop method of operation is desirable due to the simplicity of machine operation and due to the fact that open shop operation stimulates interest at the problem solving level and permits our design engineers to telescope years of design experience into a few months.

Methods of training used includes formal programming training by manufacturer, individual instruction by installation employees, and on-the-job training.

Burroughs Corp., 14300 Tireman

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	1	1
Clerks	1	1

Operation tends toward closed shop.

Method of training used is classroom type training.

Burroughs Corp.

One part time operator is required.

Operation tends toward open shop.

Method of training used is personal instruction.

E, G & G, Inc.

	One 8-Hour Shift
Supervisors	1
Analysts	2

Operation tends toward closed shop.

Methods of training used is two day programming and operators course given by our own personnel to indoctrinate new analysts.

STL

Two programmers used and recommended.

Operation tends toward closed shop.

Method of training used is on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USAD, Kansas City

Good time 40.2 Hours/Week (Average)
Attempted to run time 40.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.992
Above figures based on period 1 Jan 60 to 1 Jul 60
Passed Customer Acceptance Test Jan 58
Time is not available for rent to outside organizations.

Good time includes production and testing. Attempted to run time includes production and testing and wasted effort due to machine errors.

Burroughs Corp., 14300 Tireman

Good time 35 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period from Jan 58 to Jan 59
Time is not available for rent to outside organizations.

Burroughs Corp.

Good time 9.5 Hours/Week (Average)
Attempted to run time 10 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Nov 57 to Jul 60
Time is available for rent to outside organizations.

E, G & G, Inc.

Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Feb 57 to Aug 60
Passed Customer Acceptance Test Feb 57
Time is not available for rent to outside organizations.

We used this computer at Las Vegas, Nevada, for nuclear weapons test data processing April-October, 1957. During that time it was on a two shift, seven day week operation. Performance was excellent.

STL

Good time 38.5 Hours/Week (Average)
Attempted to run time 36 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period from Apr 60 to Jun 60
Passed Customer Acceptance Test Feb 57
Time is available for rent to qualified outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Card output adapter permits connection of a keypunch to enable output data only from the computer accumulator. The multiple input adapter enables the simultaneous connection of a punch paper tape input and a punch card input, a duplex paper tape input, and a punched card input or a duplex paper tape input and a second paper tape input.

Unique system advantages include ease of programming and complete formatting ability with the Burroughs Sensimatic Printer.

USAD, Kansas City

Outstanding features are ease of programming, operation and debugging. A complete ADPS installation is contained in the basic machine.

The addition of a tape input unit increases the capacity of the E-102, but the machine is, in most cases, too slow for long and complex problems that require large amounts of data input.

Burroughs Corp., 14300 Tireman

Outstanding features are ease of operation and it brings advantages of electronic computation into the area of small calculating problems.

Burroughs Corp.

Outstanding features are ease of operation and electronic speed on small calculating problems.

E, G & G, Inc.

Unique system advantages are compactness, high amount of up time with minimum service requirements.

FUTURE PLANS

USAD, Kansas City

A request to discontinue rental of the Burroughs E-102 Electronic Computer with tape input unit and to install an IBM 1620 Data Processing System is under consideration. This new system would increase the problem solving capacity of the district and will also lend itself to the solution of more complex problems which, at this time, due to machine limitations (storage and speed), are not feasible or practical.

The new system, if approved, would include:

Quantity	
1	IBM 1620 Data Processing System
1	IBM 046 Tape to Card Converter
1	IBM 063 Card to Tape Converter
1	IBM 022 Printing Card Punch
1	IBM 056 Card Verifier
1	IBM Series 50 Card Sorter
1	Model FPC-8 Flexowriter

E, G & G, Inc.-Possibility exists of replacing current computer with newer versions in same operating and price ranges.

INSTALLATIONS

U.S. Army Engineer District, Kansas City, Mo.
Burroughs Corporation, 14300 Tireman, Detroit, Mich.
Burroughs Corporation, 6071 2nd Ave., Detroit, Mich.
Edgerton, Germeshausen & Grier, 160 Brookline, Boston
Space Technology Laboratories, El Segundo, Calif.
University of Pennsylvania, 200 S. 33rd St, Phila 4, Pa.

BURROUGHS E 103

Burroughs Model E 103 Electronic Digital Computer

MANUFACTURER

Burroughs Corporation

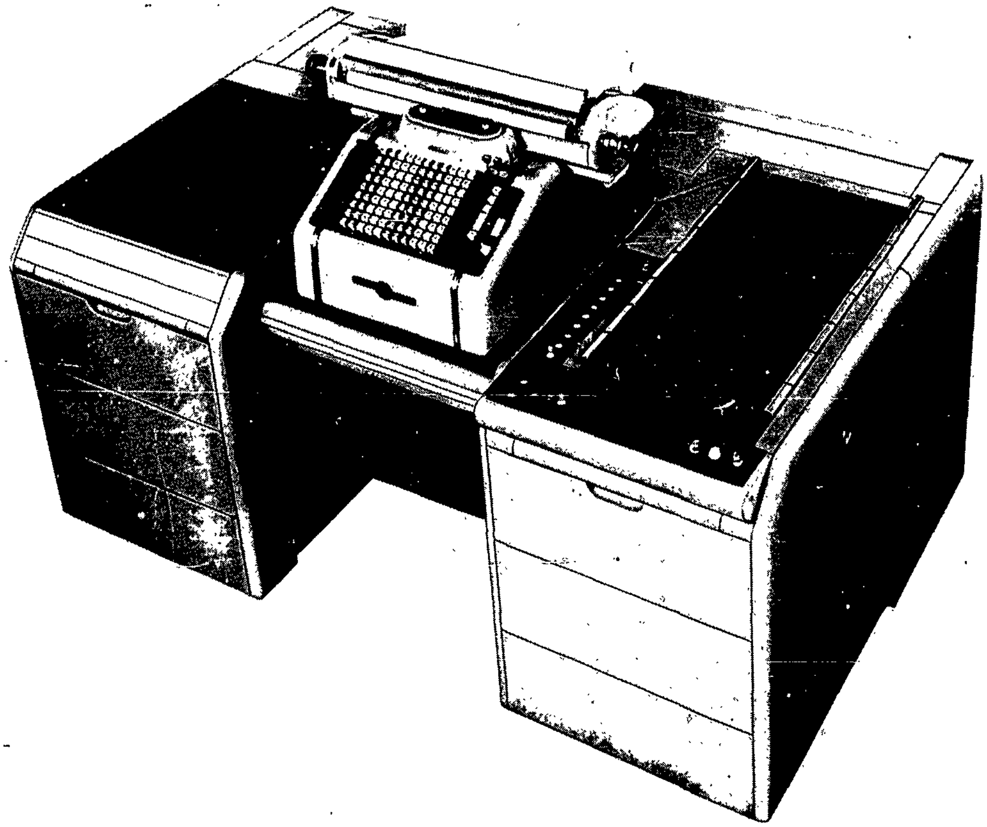


Photo by the Burroughs Corporation

APPLICATIONS

Manufacturer

Desk size system for general purpose computing.

David Taylor Model Basin

Located on the second floor of the Hydromechanics Laboratory building, the system is used for solving engineering and scientific problems by the engineer an scientist in order that he get a feel for the problem, particularly if the problem is not sufficiently complex to justify programming on a larger computer, such as the IBM 704.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Decimal
Decimal digits/word	12 plus sign
Arithmetic system	Fixed point
Instruction type	One address

Instruction word format

Operation Code	Tens level of address	Units level of address
W	1	5

W - Write contents of accumulator into cell 15, leaving copy in accumulator

Accumulator - 12 digits plus sign, "Clearing House" for all data to and from memory.

B register - 11 digits plus sign. Holds the multiplicand or the divisor during multiplication or division, respectively.

The E 103 is an externally programmed machine through replaceable pinboards. Metal contact pins dropped through the pinboard, provide the contacts to an internally wired program. 29 different commands are available before being modified by mechanical stepping switches. A maximum of 128 program steps can be stored on the machine at any one time.

Floating point may be programmed.

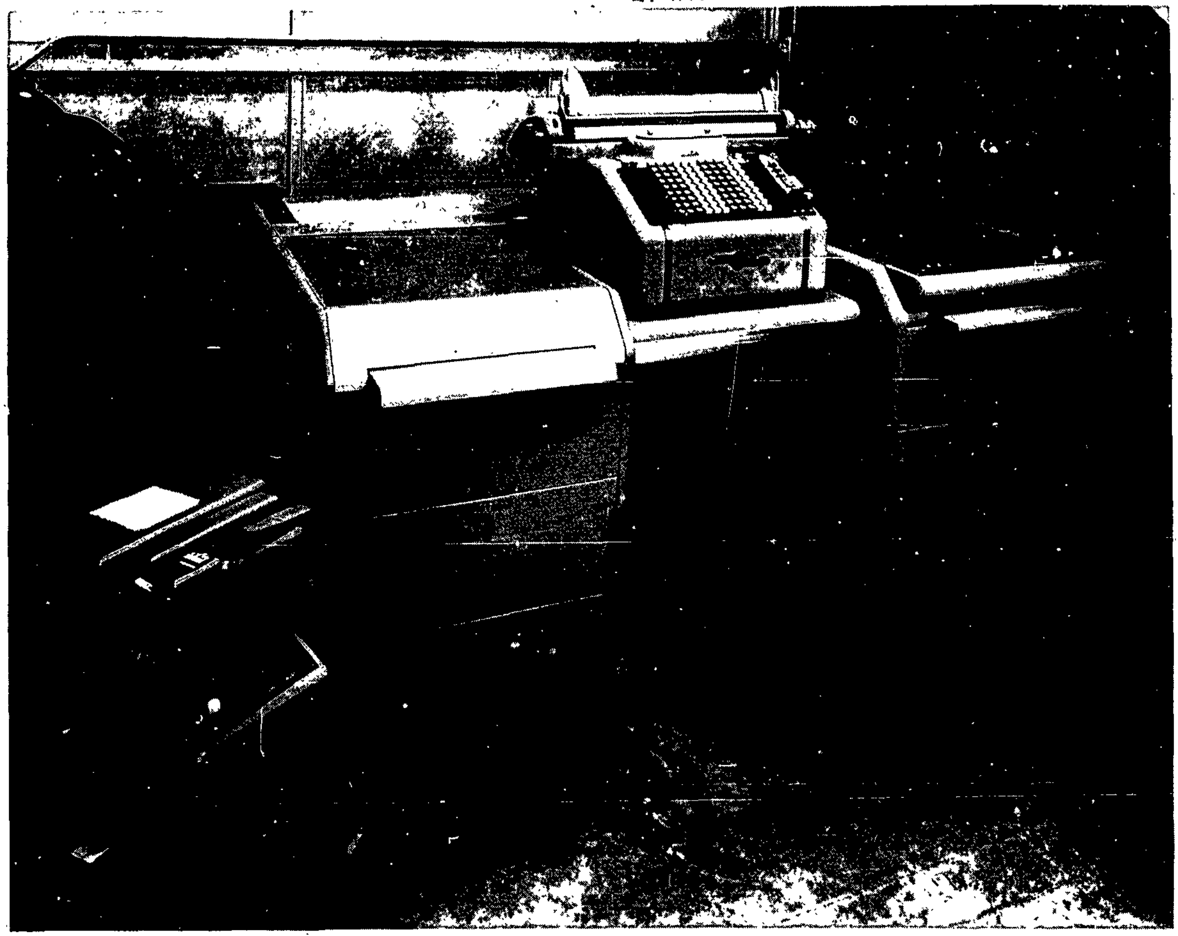


Photo by the U. S. Navy David Taylor Model Basin

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	51,000	42,500
Mult	250,000	241,500
Div	300,000	291,500

Construction (Arithmetic unit only)

Vacuum tubes	180
Diodes	1,400
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Medium	No. of Words	No. of Digits	Average Access Microsec
Drum	220	12 plus sign	8,500

INPUT

Manufacturer

Media	Speed
Keyboard	Manual
Paper Tape	20 char/sec
Card	20 or 17 card columns/sec

Field modified IBM Style 024 or 026 Keypunch with Burroughs Translator. An 11 column keyboard is used.

OUTPUT

Manufacturer

Semi-Ganged Printer	24 digits/sec
Punched Paper Tape	10 char/sec
Punched Card	20 or 17 card column/sec

Field modified IBM Style 024 or 026 Keypunch with Burroughs Translator

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Vacuum tubes	250
Diodes	2,000

CHECKING FEATURES

Manufacturer

Checking features include pin check (missing pins), print check, overflow alarm, memory alarm in case of failure to read or write properly, and keyboard check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	1.85 Kw 2.2 KVA 0.85 pf
Volume, computer	40 cu ft
Area, computer	16 sq ft
Room size	10 ft x 10 ft
Floor loading	93 lbs/sq ft
Weight, computer	1,500 lbs

Air conditioning is required if room temperature is higher than 90°F. 1 1/2 tons of air conditioning is recommended when the room temperature is higher than 90°F. Two 3/4 ton window units are satisfactory.

David Taylor Model Basin

Room size	Small office approx. 50 sq ft
Air conditioner	Window type unit
Capacity, air conditioner	1 Ton

Required 220 volt, single phase, 3 wire line.

PRODUCTION RECORD

Manufacturer

Number produced to date	210
Number in current operation	166
Number in current production	54
Anticipated production rate	60/year
Time required for delivery	3 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Cost	Monthly Rental
E 103 Computer	$29,750	$875
Paper Tape Input	2,950	85
Duplex Tape Reader	2,150	65
Punched Card Input	3,450	105
Punched Card Output	2,375	70
Multiple Input Adapter	575	20
Punched Tape Output	2,950	85

First year maintenance is rendered gratis on purchase, $2,000/year including maintenance, parts, travel time, thereafter. Maintenance is included in lease rate.

David Taylor Model Basin

Basic computer expanded memory drum, tape input and tape output rent at $1,380/month.

PERSONNEL REQUIREMENTS

Manufacturer

Training is made available by the manufacturer to the user. No assigned personnel are required if system is operated on an open shop basis.

David Taylor Model Basin

The machine is a simple programmed desk size computer that requires no specialized operators. The engineer and physicist programs and runs his own problem.

Classes are held (less than a week long) whenever the occasion demands.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Design of machine coupled with preventive maintenance schedule has provided experience of 97.3% up-time.

David Taylor Model Basin

Good time	16.7 Hours/Week (Average)
Attempted to run time	17.2 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period 1 Apr 59 to 31 Mar 60
Passed Customer Acceptance Test 11 Jun 57
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include low cost, external programming, and a great variety of input-output adjuncts. Printer versatility, due to design, includes a semi-ganged printer, front feed carriage, and an accounting machine carriage movement.
Unique system advantages are that the system is an ideal open shop computer and is perfectly suited for business, engineering, statistical and scientific computing.

FUTURE PLANS

Manufacturer

System will be up-dated on a continuing basis.

INSTALLATIONS

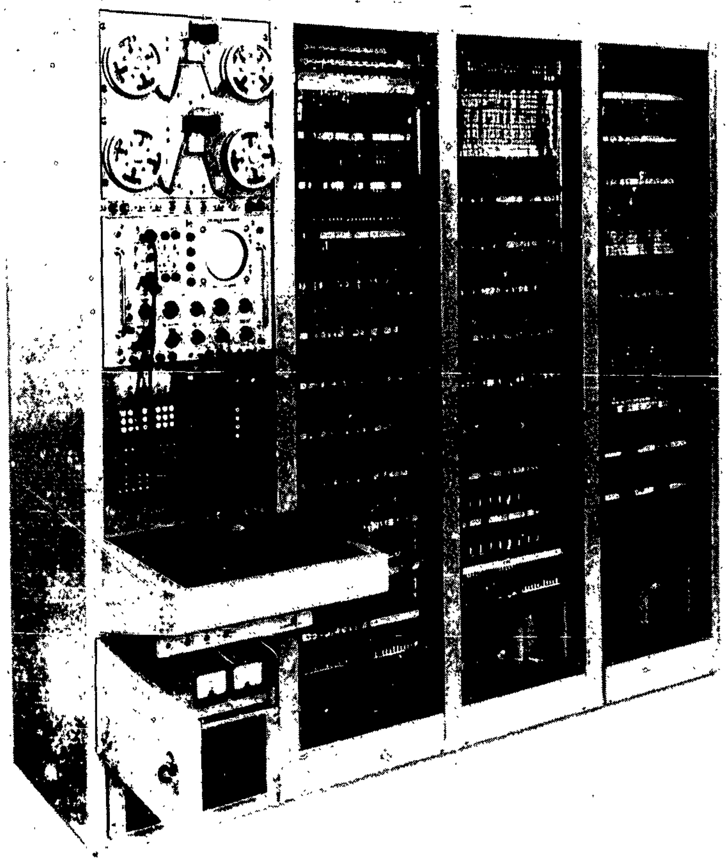
David Taylor Model Basin
Hydromechanics Laboratory
Washington 7, D. C.

CCC REAL TIME

General Purpose Real Time Tracking Computer

MANUFACTURER

Computer Control Company, Incorporated



Front View

Photo by Computer Control Company, Incorporated

APPLICATIONS

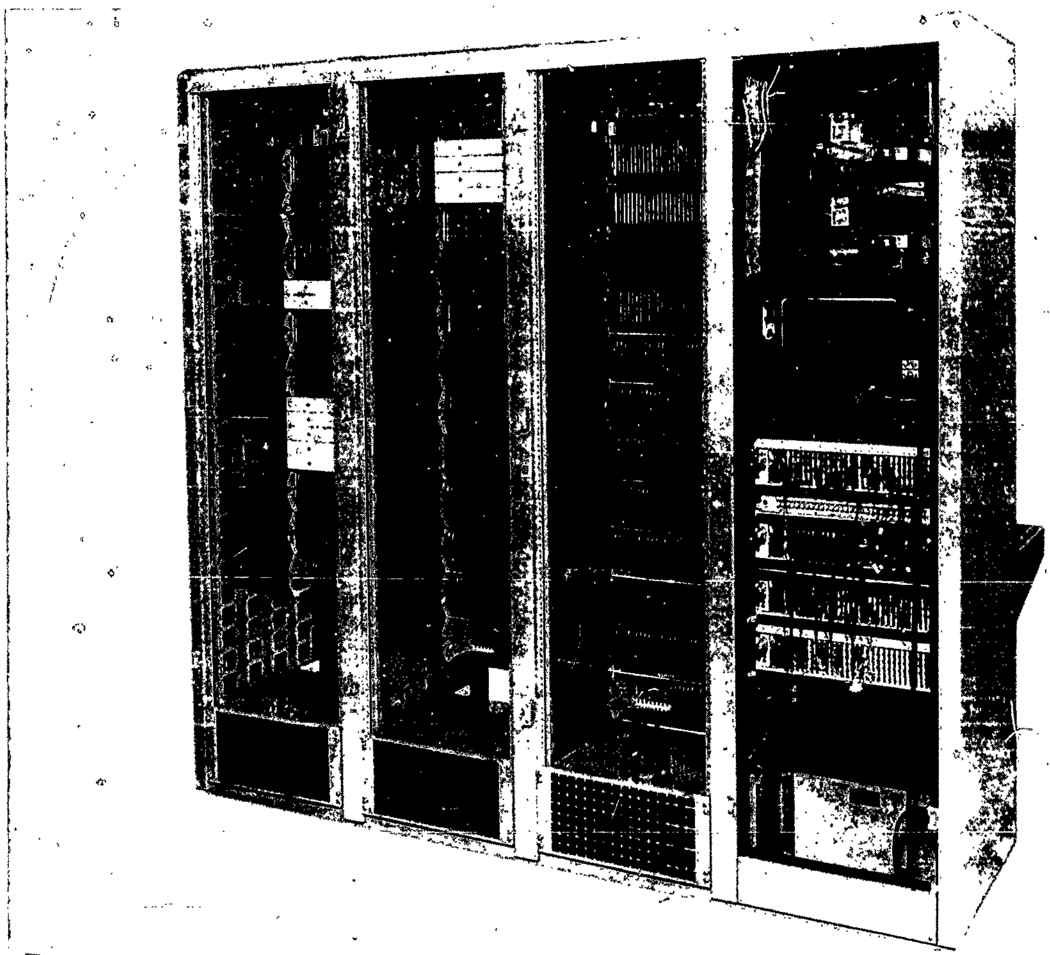
The system was specifically designed for use in providing real-time command signals to position two 85' parabolic antennas from various input sources. The computations involve parallel correction, orbital integration, coordinate translation, rotation and conversion. The computation must be slaved to real time and solution time must be extremely fast to reduce system real time phase shift. Flexibility and future system requirements are provided by the general purpose stored program philosophy.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	25
Binary digits/instruction	25
Instructions per word	1
Instructions decoded	48
Arithmetic system	Fixed point
Instruction type	One plus one

Instruction contains one operand address and next instruction address

Number range	± 1



Rear View

Photo by Computer Control Company, Incorporated

Instruction word format

Operation Code	Address 1	Address 2	Index Control

Automatic built-in subroutines include sine/cosine resolver, octant reduction, and Binary Coded Decimal-Binary conversion.

There are 3 index registers which may be incremented, replaced or cleared and are capable of modifying either address under control of two index control bits located in each instruction.

ARITHMETIC UNIT

Operation	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	25	25
Mult	75	50

Construction (Arithmetic unit only)
Transistors 540
Arithmetic mode Serial-parallel

Additions are performed in serial, multiplication is performed in serial-parallel to achieve 50 microsec multiply time.

Timing Synchronous
Operation Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Acoustic Delay Line (Instruction Storage)	320	8,000	500 Avg.
Acoustic Delay Line (Data Storage)	160	4,000	250 Avg.
Electromagnetic Delay Line	8	200	25

INPUT

Media	Speed
Paper Tape	60 octal digits/sec

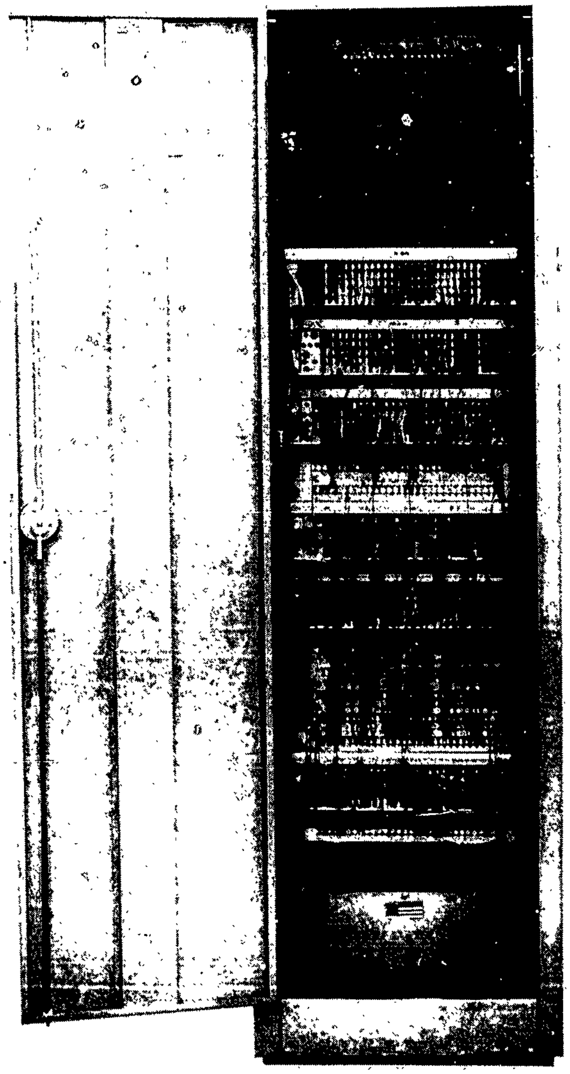
Program input tape and position command tape

Antenna Readout	4,000 18 bit words/sec

4 registers containing antenna positions of azimuth, elevation, hour angle, and declination

Theodolite	1,000 readings/sec
Keyboard	

The read time from central range timing system is also made available to the computer for programming utilization.



Digital Servo Photo by Computer Control Company, Incorporated

OUTPUT

Media	Speed
Readout to Digital Servo	1 reading/sec
Computer output drives 4 command registers, two for each antenna.	
Printer	4 words/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	22,000
Transistors	2,700

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.4 Kw
Volume, computer & digital servos	105 cu ft
Area, computer & servos	15 sq ft
Floor loading	150 lbs/sq ft 150 lbs concen max
Weight, computer	2,200 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	6 months

COST, PRICE AND RENTAL RATES

The cost of the entire system, including 2 digital servo racks and all development, installation and programs is $330,000.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Operators	1
Engineers	1

Training made available by the manufacturer to user includes operation and maintenance. The programs having once been prepared are utilized without need of further programming unless the computer is to be used for new and different modes of operation. Since the existing programs meet the present system needs, no current programming effort is utilized.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability includes completely transistorized and modularized construction. Package types are limited to 8. 98% of the systems utilize 4 package types.

ADDITIONAL FEATURES AND REMARKS

The arithmetic unit is designed to perform fast computation of trigonometric functions. The quantity a + bx + c may be formed in 50 microsec. The system operates in real time and is synchronized to external range timing system.

CDC 160

Control Data Corporation Model 160

MANUFACTURER

Control Data Corporation

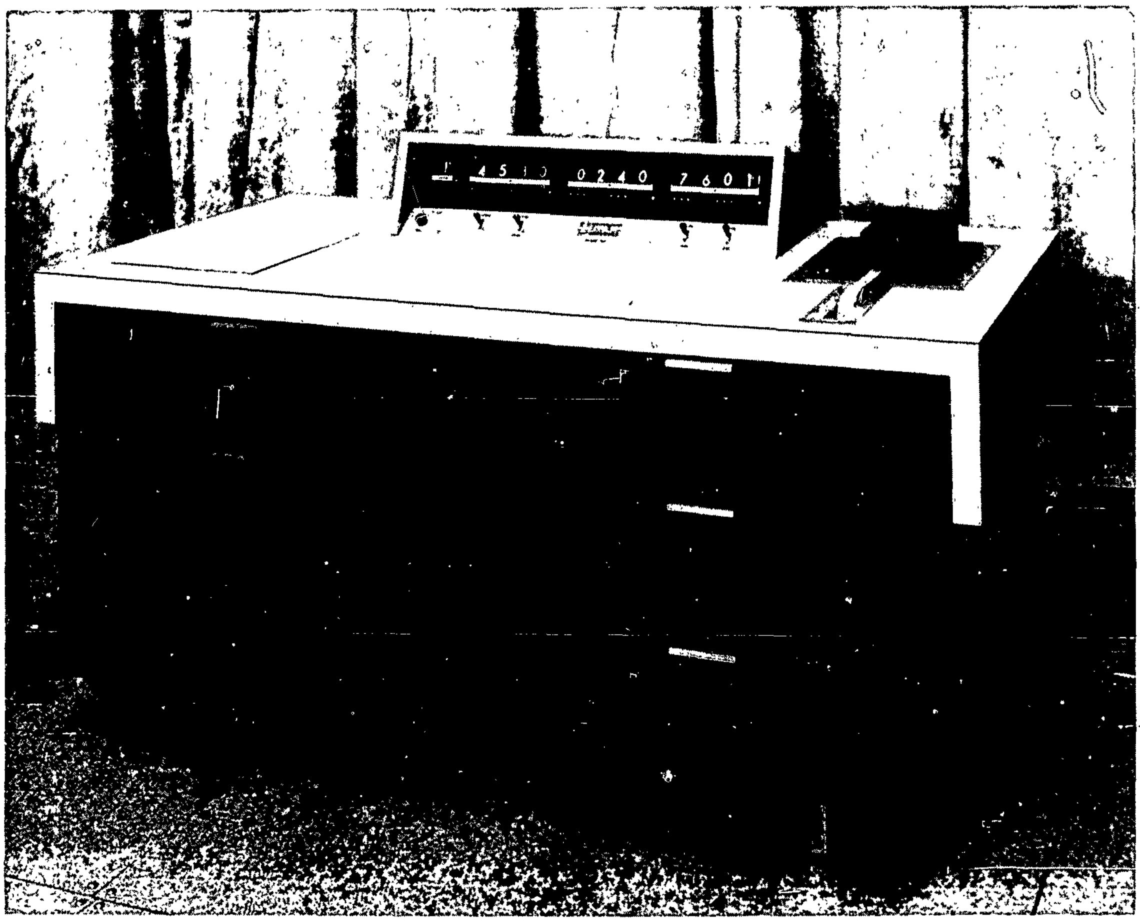


Photo by Control Data Corporation

APPLICATIONS

The fields of application include off-line data conversion, data processing - scientific, data processing - commercial, construction, machine tool design, optical design, data acquisition and data reduction, and as a satellite system with the CDC 1604 Computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	12
Binary digits/instruction	12
Instructions/word	1
Instructions decoded	63
Arithmetic system	Fixed point Mod $2^{12} - 1$
Instruction type	One address

Flexible addressing modes include no address, direct address, indirect address, and relative address. Information in registers shown on projection display in Arabic numerals.

Instruction word format

Function	Address
6 bits	6 bits

ARITHMETIC UNIT

Operation	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	6.4, 12.8, 19.2	6.4
Mult	Programmed	1,000
Div	Programmed	1,800

Construction (Arithmetic unit only)
Transistors and Diodes

Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

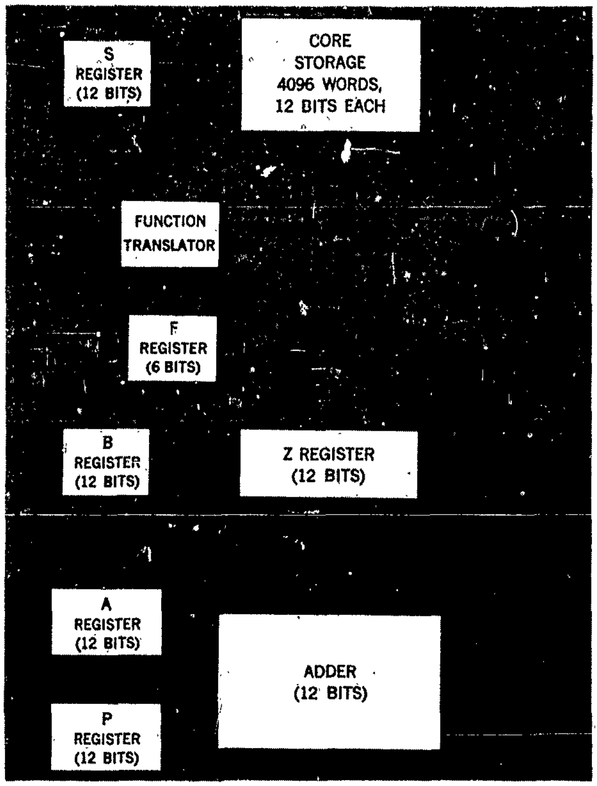


Diagram by Control Data Corporation

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Core Storage	4,096	49 and 52 bits	6.4

Magnetic Tape

No. of units that can be connected	30	Units
No. of chars/linear inch of tape	200	Chars/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating each record	0.75	Inches
Tape speed	75 or 150	Inches/sec
Transfer rate	15,000 or 30,000	Chars/sec
Start time	5	Millisec
Stop time	5	Millisec
Average time for experienced operator to change reel of tape	45	Seconds
Physical properties of tape		
Width	1/2	Inches
Length of reel	3,600	Feet
Composition		Mylar

INPUT

Media	Speed
Paper Tape (Ferranti)	350 char/sec
Typewriter	

OUTPUT

Media	Speed
Teletype Punch	60 char/sec
Typewriter	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	7,000
Transistors	1,400
Magnetic Cores	49,152

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer only	0.7 Kw	1.0 pf
Volume, computer	20 cu ft	
Area, computer	10 sq ft	
Floor loading	700 lbs concen max	

Room size is dependent on peripheral equipment selected.

Weight, computer	700 lbs

Air conditioner is dependent on room size and peripheral equipment. System uses 110v, 60 cycle power.

PRODUCTION RECORD

Number produced to date	7
Number in current operation	4
Number in current production	25
Anticipated production rates	1 per week
Time required for delivery	6 months

COST, PRICE AND RENTAL RATES

	Purchase Price	Lease Price/ Month
160 Computer	$60,000	$1,500
Electric Typewriter	10,500	262
1609 Card Read & Punch Unit	47,000	1,175
Basic Magnetic Tape Unit (30 KC)	37,000	925
Additional Magnetic Tape Units (30 KC)	20,500 (ea)	512 (ea)
Basic Magnetic Tape Unit (15 KC)	32,000	800
Additional Magnetic Tape Units (15 KC)	15,500 (ea)	390 (ea)
1606 High Speed Printer	110,000	3,300

All prices are f.o.b. Minneapolis, Minnesota, and do not include Federal, State and Local Taxes which may be applicable. Subject to change without notice.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Programmers	2
Technicians	1

Training made available by the manufacturer to users includes regularly scheduled training courses are made available to customer personnel. Cost of training is included in the equipment price.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability includes solid state unitized construction and wide tolerances designed into all circuits.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include high speed input-output, flexible address features, low cost, and magnetic core memory.

Unique system advantages include satellite operation with Control Data Corporation 1604 Computer, small size, and high speed.

Electric Typewriter
This is an IBM electric typewriter modified by Soroban Corporation. It has a standard keyboard. The typewriter is mounted on a cabinet with the controls and power supply inside the cabinet -- connected to the 160 by the input-output cable. It accepts input data at normal typing speeds. It prints output data from the 160 at a rate of 10 to 12 characters per second. Associated with the typewriter is a control panel. It houses two switches and two lights. The switches denote Operation Mode and Input Disconnect.

1609 Card Read and Punch Unit
This is an IBM 521 punching unit. It provides the 160 with punched card input and output. There are three card stations: first reading station, punching station, second reading station. Calculated results are punched at the punching station. At the second reading station, a card can be read for gang punching, re-calculation for proof, and double punch, blank column checking. Cards are fed continuously without interruption for calculation. As the results are being punched in one card, factors are being read from the following card. May be operated as an independent gang punch. It operates at a speed of 100 cards per minute. Two double section, 22-hub control panels and standard complements of self-contacting wires are furnished.

Basic Magnetic Tape Unit
It contains controls for a total of four tape handlers. Uses Ampex FR-300 tape handler, with a character rate of 30 KC. "Change-on-ones" type of recording is used compatible with that used by IBM 727 tape units. Reflective spots indicate beginning and end of tape. Thus, a reel of tape generated by the tape unit can be used on an IBM 727 tape unit and vice versa. Forward, reverse, and rewind tape speed is 150 inches per second. Recording density is 200 characters per inch, with 6 information bits and one parity bit per character. Tape width is 1/2 inch. Data is recorded in variable-length blocks, with practical limits determined by the size of memory. Length of inter-block spacing is approximately one inch. Data transmissions to and from the tape system are in the form of 6-bit words. Tape can be read in either the forward or backward direction. For writing, the control section receives a 6-bit word and generates a parity bit for each word. Reading follows the reverse procedure: 7-bit characters are read off the tape and the lower 6 bits are transmitted to the computer. Parity checks are made on reading and writing by a read-head mounted 0.4 inches following the write head. Parity errors are registered on a flip-flop for subsequent sensing by the computer. A parity error does not immediately halt operations, unless a program stop is specified. The reading and recording heads are electrically isolated on this tape unit. This feature allows the tape to be read back during recording for a positive check on both the recording circuits and the magnetic tape quality. Same unit is available using FR-400 tape handler, with a character rate of 15 KC. Additional magnetic tape units are available.

1606 High Speed Printer
The Line Printer consists of an Anelex series 56-160 printer and the necessary control circuitry. This printer provides high speed printing at a normal rate of 350 lines per minute. It will handle forms from 4 to 20 inches wide and any length up to 22 inches. It provides 120 columns of characters and 47 characters per column. These may be digital, digital and signs, or full alpha-numeric; also foreign language and plotting symbols. It will print on single or multiple carbons, pressure sensitive or heat transfer type papers, pre-printed forms or card stock.

Additional Description - General
Operation of the 160 is sequenced by an internally stored program. This program, as well as the data being processed, is contained in the high-speed, random-access memory. An instruction is a 12-bit word consisting of: a 6-bit function code F, and a 6-bit execution address E. By means of the direct, relative, and indirect addressing features, it is very simple to operate on data in the computer and to make program modifications when desired.

A general purpose input channel and output channel are provided for attaching a variety of input-output devices to the 160 Computer. Standard input-output equipment consists of a Ferranti punched paper tape reader that reads 350 characters per second; and the Teletype high-speed paper tape punch that operates at 60 characters per second. Optional input-output equipment includes an on-line electric typewriter, up to 8 magnetic tape handlers (Ampex FR-300 handlers that operate at 30 KC character rate or Ampex FR-400 handlers that operate at 15 KC character rate), card reader-punch units, and line printer. Input-output transmissions are either a single 6-bit or 7-bit character, or a 12-bit word.

Description of Registers
The 160 Computer contains three operational registers: A, Z, and P. The contents of these registers are shown in arabic numerals (octal notation) on the control panel of the computer. There are also three transient registers: B, F, and S. These registers are described below; a block diagram of the 160 Computer is shown in the figure.

A Register (12 bits): principal arithmetic register. For most arithmetic operations, A operates as a 12-bit subtractive accumulator. The quantity zero is represented by all zeros.

Z Register (12 bits): performs several functions. One, it serves as a buffer register for storage. In this capacity, it receives the word read out of storage and holds the word to be written into storage. Also, for addition and subtraction operations, the contents of the Z register are added to or subtracted from the contents of A.

P Register (12 bits): program control register. Its contents are the address of the current instruction. At the beginning of each instruction, the contents of P are increased by one to provide the address of the instruction; a jump address is entered in P if a jump is called for.

B Register (12 bits): auxiliary arithmetic register. The results of arithmetic operations are first formed in B, then transmitted to the A, Z, or S registers.

S Register (12 bits): functions as the storage address register. Prior to any storage reference, the address word is entered in S. The contents of S are then used to select the storage location involved in the reference.

F Register (6 bits): holds the upper six bits of an instruction word, i.e., the function code, throughout the execution of an instruction. The execution of an instruction is under the control of the quantity in F.

Addressing Modes

In the direct addressing mode, the address refers to a 12-bit operand in one of the first 64 storage locations.

Indirect addressing provides for operand references and jump addresses. Where indirect addressing is used with an instruction, E refers to one of the first 64 storage locations; the contents of this register are then read out and used as the address of the operand or as the jump address.

Relative addressing provides for operand addresses and jump addresses that are in the immediate vicinity of the storage location which contains the current instruction. In relative addressing forward, the E portion is added to the current contents of the program control register P. Thus, the operand or jump address is one of the 63 storage locations immediately preceding the address of the current instruction. An exception is the Indirect Jump, in which the jump address is read from the address found when the contents of P are added to E.

In the no address mode, constants are stored in the address portion of the instruction. The E portion of the instruction is not used as an address. Instead, it is used as a 6-bit operand. This operand is automatically extended to 12 bits, with the upper six bits being zeros. With this feature, arithmetic and logical operations can be carried out with a 6-bit quantity contained in the instruction. Thus the need for entering many constants into memory is eliminated.

CDC 1604

Control Data Corporation Model 1604

MANUFACTURER

Control Data Corporation

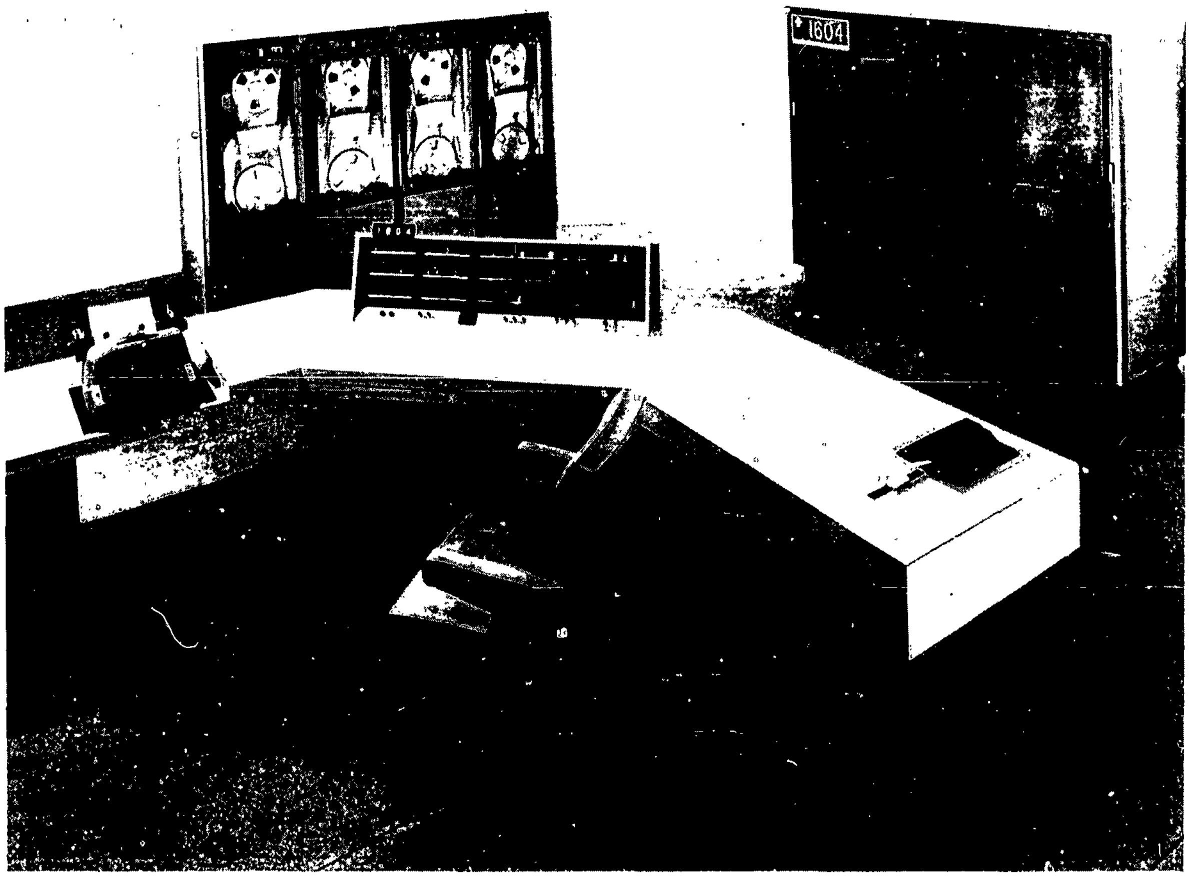


Photo by Control Data Corporation

APPLICATIONS

Manufacturer

Actual applications include engineering, scientific, business, radar, missile tracking, and educational.

U.S. Naval Postgraduate School

Located at Monterey, California, the system is used for scientific applications, including student and faculty research in practically all phases of the physical sciences; for data processing, including weather prediction, and for simulation, including electronics systems, and games (business, industrial and military).

National Bureau of Standards - Boulder, Colo.

Located at Boulder, Colorado, the system is used for scientific computing on Radio Propagation, Radio Standards, and Cryogenics Research.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary
Binary digits/word	48
Binary digits/instruction	24
Instructions per word	2
Instructions decoded	62
Arithmetic system	Floating point one's complement Fixed point one's complement
Instruction type	One address
Number range	Fixed point $\pm (2^{47} - 1)$ Floating point 10 bit exponent plus sign, 36 bit coefficient plus sign

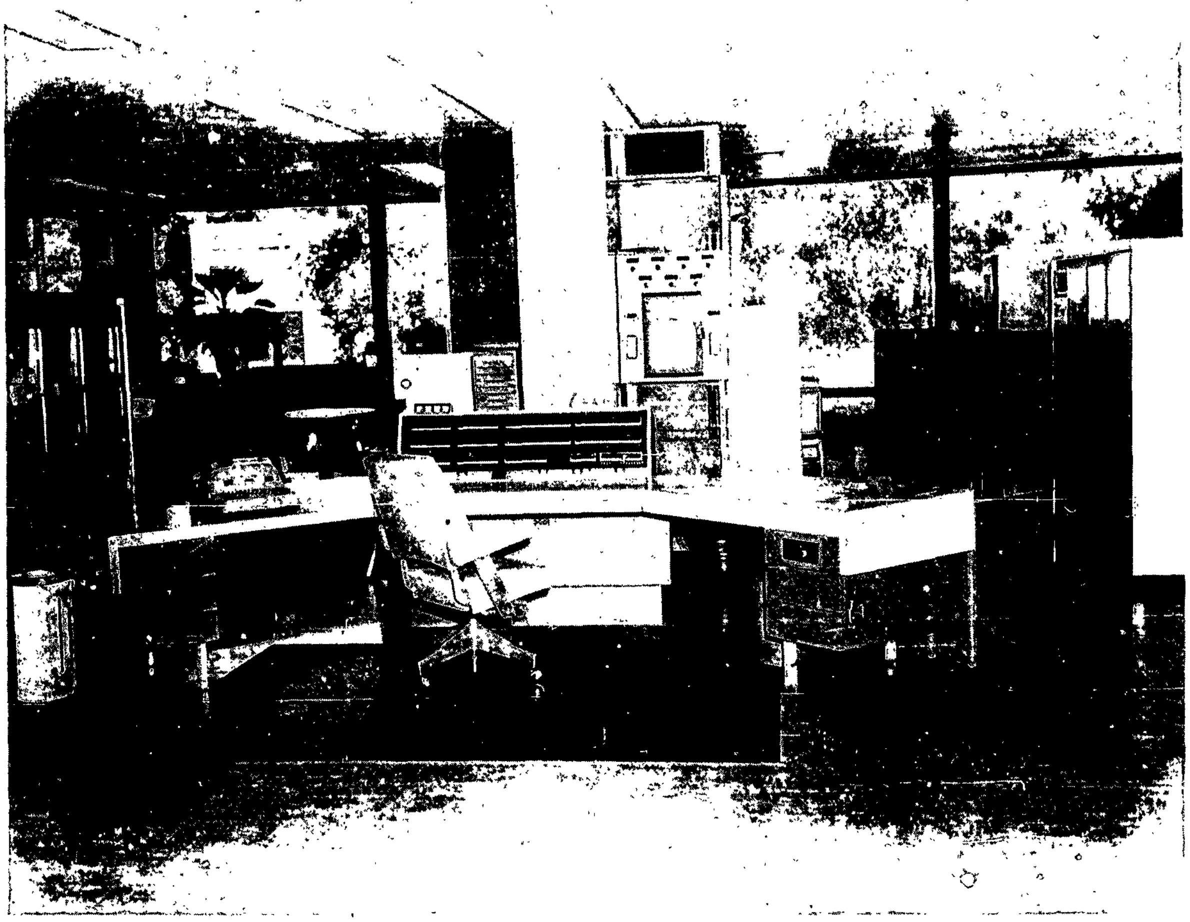


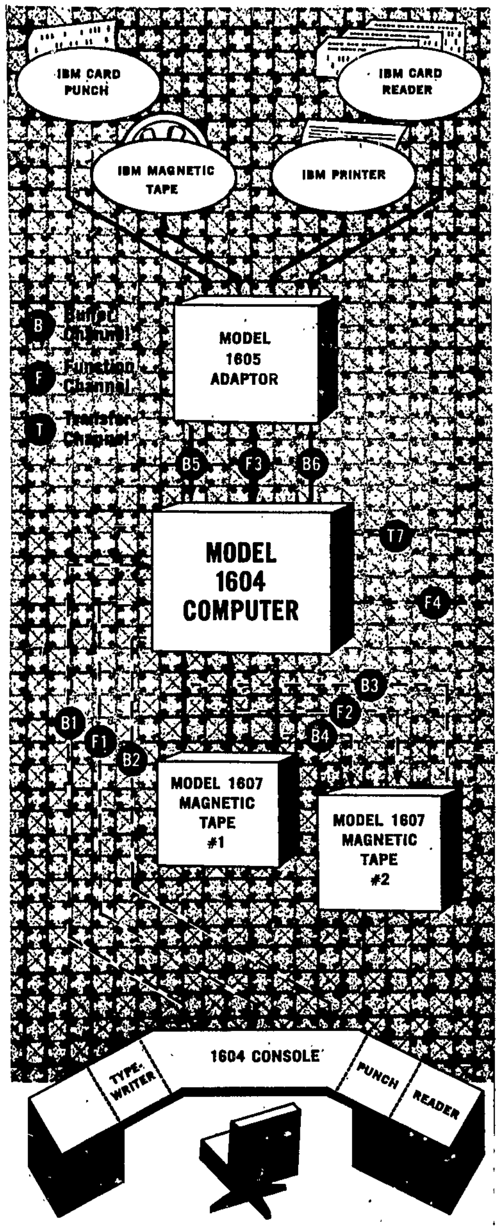
Photo by U.S. Navy - Post Graduate School

Instruction word format

6 bits	3	15
Instruction Code	Index Design.	Execution Address

Indirect addressing built in.
Registers include 6 index registers of 15 bits each and a Ones-complement arithmetic register.
A-Register (Operational) Principal arithmetic register. Functions as a 48-bit accumulator in most arithmetic operations. Quantity zero represented by a binary zero in each stage. Contents of A may be shifted either to the right or left. Shifting may involve only the contents of A or may include the contents of Q. Leftmost sign bit extended on shifts to right; bits shifted off the right end of A or Q are dropped. Left shifts are circular, with lower order bits being replaced by higher order bits. Multiply, divide, and floating point instructions are sequenced operations involving both A and Q.
Q-Register (Operational) Assists accumulator in performing more complicated arithmetic operations. Used with A to perform double precision arithmetic. Q may be shifted right or left, singly or in conjunction with A. Q also contains mask in logical operation.
Program Control Register, U1 Holds program step while the two instructions contained in it are executed. The 48-bit instruction word taken from storage location specified by P and entered in U1, the upper instruction being executed first. Execution of lower instruction follows, except when upper instruction is a jump or when it provides for conditional skipping of lower instruction.
Auxiliary Program Control Register, U2 An accumulator used in the modification of execution address of current instruction. This modification consists of adding contents of an Index Register to execution address of current instruction.
P-Register (Operational) Functions as the program address counter. Provides continuity between individual steps of program by generating the addresses at which individual steps are contained. Upon completion of each sequential step, count in P is advanced by one to specify address of next step. Jump instructions clear P and enter new address in it.
Index Registers, B1-B6 (Operational) Provide modi-

Diagram of Model 1604 Input-Output Facilities



fication of execution addresses in program loops. Contents of an Index Register can be advanced each pass through a loop, with an exit initiated on a given threshold. Alternate approach allows an Index Register to be preset, then reduced by one count each pass through the program-with an exit after zero.

Storage Address Registers, S1-S2 Represent even and odd 16,384-word memory units respectively. Receive addresses of instructions from P and addresses of operands from U2.

Storage Restoration Registers, Z1-Z2 Represent even and odd 16,384-word memory units respectively. Hold the 48-bit word to be written in a given storage location.

R-Register Functions as exchange register for transmission involving B-Index Registers. Used in advancing or reducing count in a given B-Register. During several instructions, used to count repetitive operations. R used with floating point instructions in performing arithmetic operations on the exponent or characteristic.

X-Register An exchange and auxiliary arithmetic register. All input-output data passes through X.

External Function Register, 00 Used for exchanging control information with input-output equipment.

Output Registers, 01 through 04 01 through 03 used for output buffer operations where data is transmitted at speed of input-output equipment. Where high-speed transfer is required, output transfer operations carried out via 04.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	4.8 - 9.6
Mult	25.2 + .8N
Div	63.6 - 66.4

N = Number of ones in multiplier

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Manufacturer

Media	No. of Words	No. of Digits
Magnetic Core	32,768	48

Magnetic Tape

No. of units that can be connected	24 Units
No. of characters/linear inch	200 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	3/4 Inches
Tape speed	150 Inches/sec
Transfer rate	30K Chars/sec
Stop time	1.2 Millisec
Average time for experienced operator to change reel of tape	20 Seconds
Physical properties of tape	
Width	1/2 Inches
Length of reel	2,500 Feet

24 tape stations is a practical maximum, although more may be used.

U.S. Naval Postgraduate School

Medium	No. of Words	No. of Dig/Word	Access Microsec
Magnetic Core	32,768	48	approx. 4.8

National Bureau of Standards - Boulder, Colo.

Magnetic Core	32,768	48	4.8 (effective)

INPUT

Manufacturer

Media	Speed
Paper Tape	350 char/sec
Typewriter	
Punched Cards	150 cards/min
Magnetic Tape	30,000 char/sec

Faster punched card units will be available soon.

U.S. Naval Postgraduate School

Paper and Magnetic Tapes

National Bureau of Standards - Boulder, Colo.

Media	Speed
IBM 088 Collator	650 cards/min
Two read feeds are available.	
Paper Tape (Ferranti)	350 char/sec

OUTPUT

Manufacturer

Media	Speed
Paper Tape	60 char/sec
Typewriter	
Punched Cards	100 cards/min
Magnetic Tape	30,000 char/sec
Line Printer	667/1,000 lines/min

U.S. Naval Postgraduate School

Paper Tape	60 char/sec
Magnetic Tape	150 in/sec 200 char/in
Monitoring Typewriter	
IBM 717 Printer	150 lines/min 120 char/line

Off line Mag tape to printer

National Bureau of Standards - Boulder, Colo.

IBM 523 Punch	100 cards/min
IBM 407 Printer	150 lines/min
Magnetic Tape	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity
Diodes	100,000
Transistors	25,000
Magnetic Cores	1,500,000

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	7.5 Kw
Volume, 1604 Computer	98 cu ft
Volume, 1604 Console	112 cu ft
Area, computer	17 sq ft
Area, console	30 sq ft
Floor loading	150 lbs/sq ft
	2,650 lbs/concen max
Capacity, air conditioner	5 Tons
Weight, computer and console	3,450 lbs
Weight, air conditioner	500 lbs

Power, space and weight figures are for 1604. Computer and console peripheral equipment is not included. The alternator is driven by a 15 HP motor.

U.S. Naval Postgraduate School

Power, computer	4 Kw
Room size	2,800 sq ft
Floor loading	200 lbs/sq ft
	700 lbs concen max
Capacity, air conditioner	25 Tons
Weight, computer	2,200 lbs

The lobby section of one of the school buildings was partitioned. False flooring, air conditioning and power were installed in the laboratory section which houses two computers (CDC-1604 & NCR-102A) and their associated peripheral equipment.

National Bureau of Standards - Boulder, Colo.

Power, computer	15 Kw
Room size	24 ft x 24 ft
Capacity, air conditioner	6 Tons

System is installed on a raised floor in a specially prepared computer room.

PRODUCTION RECORD

Manufacturer

Number produced to date	6
Number in current operation	6
Number in current production	10
Number on order	6
Anticipated production rates	1 per month
Time required for delivery	9 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Purchase Price	Lease Price/Month 1 Year Contract	3 Year Contract
Basic computer, with 8,192 words Mag Core Stor	$750,000	$22,500	$18,750
16,384 words Mag Core Stor	830,000	25,000	20,750
32,768 words Mag Core Stor	990,000	30,100	24,750

Above computer includes:
- Magnetic Core Storage:
- Two phase system with
- 3.2 microseconds effective cycle time, alternate banks
- 6.4 microseconds cycle time, each bank
- Fixed Point Arithmetic
- Floating Point Arithmetic Feature
- Indirect addressing
- Control and Maintenance Console
- Motor-generator
- Input Punched Paper Tape Reader (7 channels, 350 characters per second)
- Output Punched Paper Tape Punch (7 channels, 60 characters per second)
- Input/Output Modified IBM Typewriter (direct-connected)
- Installation and checkout at customer premises
- Site preparation not included
- Maintenance and instruction books

Model 1607 Magnetic Tape Subsystem	$145,000	$5,050	$3,625

Includes Magnetic Tape Synchronizer
Four magnetic tape handlers
30 KC character rate
6 information bits, 1 parity bit per character
Parity-bit check on read and write
48-bit assembly for central computer
IBM 727 Format
Note: Up to 6 Magnetic Tape Subsystems can be used with each Model 1604.

Model 1605 Adaptor	$70,000	$2,050	$1,750

Permits direct communication between Model 1604 and following IBM input/output equipment:
- IBM 714 card reader (via 759 control unit)
- IBM 727 magnetic tape units (via 754 synchronizer)
- IBM 722 card punch (via 758 control unit)
- IBM 717 line printer (via 757 control unit)

Transistor Chassis Tester $9,000 (non-automatic)

	Purchase Price	Lease Price/Month 1 Year Contract	3 Year Contract
Modifications Added after Model 1604 Construction or Delivery:			
Magnatic Core Storage: Add 8,192 words to 1604 with 8,192 words	$100,000		
Add 16,384 words to 1604 with 16,384 words	200,000		
Add Model 1607 Magnetic Tape Subsystem (each)	150,000		
Model 1606 High Speed Printer	110,000	3,300	3,300
Operates at a rate of 1,000 lines per minute with the 1604.			

All prices are f.o.b. Minneapolis, Minnesota, and do not include Federal, State, and Local Taxes which may be applicable. Prices are subject to change without notice.

U.S. Naval Postgraduate School

Computer, with 4 tape drives, console, photo electric reader and teletype punch is approx. $800,000.

IBM 717, 727 and 757 rent at approx. $2300 per month.

Maintenance/service contract with Control Data Corporation amounts to $17,500/year.

National Bureau of Standards - Boulder, Colo.

Rates for basic system is $36,660 per month.

Rental rate for IBM Input-Output equipment is $1,340/month.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Engineers	1	2	2
Technicians	1	1	2

Training made available by the manufacturer to the user includes regularly scheduled training courses, furnished for customer personnel at our plant in Minneapolis, Minnesota. These courses are included in the equipment price.

U.S. Naval Postgraduate School

	One 8-Hour Shift Used	Recommended
Supervisors	1	
Programmers	1	3
Clerks	1	3
Operators		2
Engineers	1	2
Technicians	1	2

Operation tends toward open shop.

Methods of training includes course work given in the Engineer School on programming, operation and applications and also seminars are given at the school.

The computers are available for student and faculty research 24 hours per day. Those students and faculty who have been checked-out on the operation of the computers and peripheral equipment are permitted out-of-hours production runs on the computers. Potentially the school has approximately 1000 programmer-operators under this system. At the present time the CDC 1604 operates approximately 14 hours per day and the NCR 102A 20 hours per day, 7 days per week.

National Bureau of Standards - Boulder, Colo.

	One 8-Hour Shift
Supervisors	1
Analysts	3
Programmers	3
Operators	2

Methods of training used include programming training courses using CDC manuals.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

System features and construction techniques utilized by manufacturer to insure required reliability include solid state components throughout and wide tolerances designed into all circuits.

U.S. Naval Postgraduate School

Passed Customer Acceptance Test 16 Jan 60

Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include 48 bit word length, 6 buffer input-output channels, program interrupt feature, six index registers, and floating point arithmetic.

Unique system advantages include high speed transfer channel, and satellite operation with 160 computer.

Summary of Buffer Operation

The Model 1604 buffer control continually interrogates all communication channels to determine if a peripheral equipment is ready to send or receive information.

If a peripheral equipment has data ready for transfer, interrogation waits momentarily while a word is being buffered. The buffer control then resumes interrogating the communication channels.

Buffering initiates communication between computer memory, the three buffer input channels, and the three buffer output channels. These buffer information in and out asynchronously with the main computer program.

The three buffer input channels and the three buffered output channles, the interrupt line, and the real-time clock are rapidly scanned by a scanner which looks for action requests from all channels. These action requests are initiated by the peripheral equipment by indicator "flags". A complete scan is made in 3.2 microseconds, which corresponds to the phase rate of magnetic core memory.

When a request is detected by the scanner, the main computer program is halted momentarily to move the data between memory and the requesting channel. The main program proceeds immediately after this action unless the scanner detects that another channel has requested servicing. For example, if the system includes six 1607 magnetic tape systems, all three buffered input channels and all three buffered output channels of the 1604 can operate in the buffer mode, simultaneously servicing at full tape-rate three 1607 magnetic tape units operating in the read mode and three 1607 magnetic tape units operating in the write mode.

Summary of High Speed Transfer Operation

The main computer program performs the high-speed input-output transfer of information between 1604's or between one 1604 and peripheral equipment having comparable speed.

Only one instruction is required for a block of input or output data. A 48-bit word is transferred in or out in 4.8 microseconds.

All transfer operations are carried out via channel 7.

Summary of Program Interrupt

The Model 1604 recognizes an interrupt signal which may be either a signal indicating that a peripheral equipment has completed sending or receiving information or it may be a fault condition, e.g., an overflow.

A subroutine determines what has caused the interrupt, e.g., what specific peripheral equipment is causing the interrupt and on which channel the interrupt is taking place.

The subroutine takes action with the originating peripheral equipment by first removing the interrupt signal to prevent re-recognition.

The appropriate condition is set up in compliance with the interrupt. If it has come from a peripheral equipment, the action is completed-after which there is a return to the main computer program.

Summary of External Function

This instruction provides control and communication between the Model 1604 and peripheral equipment. It contains eight sub-instructions which select and sense peripheral equipments, or activate buffer channels.

The select sub-instruction (74.0) is interpreted as follows: the leftmost 6 bits are the operation code, the next 3 bits designate that this is a select sub-instruction, the next 3 bits are the channel or internal condition selection code, the next 3 bits are the equipment selection code, and the last 9 bits specify the operation for the selected equipment.

The channel activate sub-instructions 74.1 through 74.6 are interpreted as follows: the leftmost 6 bits are the operation code, the next 3 bits designate that his is an activate sub-instruction (plus indicating the channel), and the last 15 bits indicate the initial address for data storage in the buffer operation.

The sense sub-instruction 74.7 is interpreted as follows: the leftmost 6 bits are the operation code, the next 3 bits designate that this is a sense sub-instruction, the next 3 bits are the channel or internal condition selection code, the next 3 bits are the equipment selection code, and the last 9 bits specify the operation for the selected equipment.

Model 1607 Magnetic Tape System

A Model 1607 Magnetic Tape System consists of four Ampex magnetic tape handlers. The system is self-contained in a single cabinet, including data-handling and control circuitry; 48-bit assembly and disassembly registers; parity bit assignment for each written character; parity bit read-check immediately following each character written; longitudinal parity bit generation and recording at end of block; parity bit detection for each character read; and end of tape sensing.

Each 1607 tape system can be connected to any of the three buffer input and three output channels, and each 1607 is independently addressable. A number of 1607's ca be connected to a 1604 Computer.

Simultaneously among these 1607 tape systems, three tape handlers can be reading, and three tape handlers can be writing. Each 1607 system has the facility for simultaneously reading from one tape handler and writing on one tape handler, while the remaining two tape handlers are rewinding. Any tape can read either in a forward or reverse direction.

Magnetic tapes of the 1607 tape system are completely compatible electrically and mechanically with IBM Model 727 magnetic tape handlers.

Model 1605 Adaptor

The Control Data Model 1605 Adaptor permits communication between the 1604 Computer and any of the following IBM peripheral equipment:

714 Card Reader (via 759 Control Unit)
727 Magnetic Tape Units (via 754 Synchronizer)
717 Line Printer (via 757 Control Unit)
722 Card Punch (via 758 Control Unit)

The 1605 selects one of these peripheral equipments, as well as the operation to be performed, on the basis of an instruction from the main computer program. For example, a buffer instruction initiates the transfer of information between the 1604 Computer and the selected equipment via the Model 1605 Adaptor. A parity check is made on all information transmitted from the 1605 to peripheral equipment.

Each 1605 Adaptor can be connected to any of the three buffer input and three buffer output channels, and each 1605 is independently addressable. The 1605 has the same 48-bit input and output buffer register characteristics as the 1607 Magnetic Tape System. A number of 1605's together with a number of 1607's can be operated with a single 1604 Computer.

For special applications, Control Data Corporation will supply special input-output adaptors for peripheral equipments, such as special display and output systems, radar and sonar systems, digital communication systems, and real-time instrumentation systems.

FUTURE PLANS

U.S. Naval Postgraduate School

Plans include procurement of the CDC 160 system consisting of the Central Processor, Card Reader and Punch, Magnetic Tape and Printer. This system can be connected on-line to the CDC 1604 and used either on or off line.

INSTALLATIONS

U. S. Naval Postgraduate School, Monterey, Calif.
National Bureau of Standards, Boulder, Colo.
U. S. Army Signal Corps, Signal Procurement Office, Fort George G. Meade, Maryland
U. S. Navy, Bureau of Ships, Washington 25, D. C.
U. S. Naval Air Materiel Center, Aeronautical Structures Laboratory, Philadelphia 12, Pennsylvania
U. S. Air Force Ballistic Missile Center, Air Materiel Command, Los Angeles 45, California
U. S. Air Force 4925 T.G.A. (Area E), Kirtland Air Force Base, Albuquerque, New Mexico (Proposed)
U. S. Air Force, Vandenberg Air Force Base
U. S. Air Force Structures Test Laboratory, WADC, Wright Field, Dayton, Ohio
Convair Astronautics, Dayton, Ohio
Lockheed Aircraft Corporation, Missiles Systems Division, Sunnyvale, California (2)
Institute for Defense Analyses, Weapons Systems Evaluation Division, Room 1D863, Pentagon, Wash 25, D.C.
Institute for Defense Analyses, Upper Payne Bldg., 76 1/2 Nassau Street, Princeton, N. J.
New York University, University Heights, NYC 53, NY
University of California, Institute of Geophysics, La Jolla, Calif.

CIRCLE
Circle Digital Computer

MANUFACTURER
Hogan Laboratories, Incorporated

Photo by Hogan Laboratories, Incorporated

APPLICATIONS

Manufacturer
General purpose, scientific computation
Engineer Research and Development Laboratories
Scientific and engineering computation

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	40 - 44 plus 2 sign digits
Binary digits per instruction	20
Instructions not decoded	3
Instructions per word	2
Instructions decoded	64
Instructions used	33

Arithmetic system	Fixed point
Instruction type	One address code
Number range	-1 to $+1$ $(1-2^{-44})$

Shift, Print, Convert Binary to Decimal, and Feed Instructions make use of Address Digits to determine number of shifts, digits, etc.

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	500
Mult	20,000
Div	20,000
Construction	Vacuum tubes

Rapid access word registers	Operating Registers
Basic pulse repetition rate	82 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Conversion from decimal to binary requires 2,000 microseconds and one instruction.

STORAGE

Medium	Words	Microsec Access
Drum	1,024-4,096	8,000 (avg)
	42-46 digits per word	

INPUT

Media	Speed
Paper Tape (Flexowriter)	10 dig/sec
Keyboard (Flexowriter)	Manual
Paper Tape (Reader)	30 dig/sec

The paper tape reader is optional.

OUTPUT

Media	Speed
Hard Copy (Flexowriter)	10 dig/sec
Paper Tape (Flexowriter)	10 dig/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	800-1,000
Tube types	3
Different plug in units	18
Separate cabinets	2

CHECKING FEATURES

Even-odd check on instructions
Programmed check is normally used.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	3 - 3.5 Kw
Volume, computer	54-81 cu ft
Weight, computer	1,600 lbs

PRODUCTION RECORD

Number produced	2
Number in current operation	2

This system is no longer being manufactured.

COST, PRICE AND RENTAL RATES

Approximate cost of basic system
$80,000 with 4,096 word storage
$60,000 with 1,024 word storage
Optional features at extra cost were:
Twenty binary digit word operation
Special orders for unusual problems checking
2,048 word storage

PERSONNEL REQUIREMENTS

Daily Operation	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Engineers	0.5	0.5	0.5
Technicians	1	2	3

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Good time	813 Hours
Attempted to run time	996 Hours
Operating ratio (Good/Attempted to run time)	0.82
Passed Acceptance Test	June 54

INSTALLATIONS

U.S. Army Corps of Engineers
Engineer Research and Development Laboratories
Fort Belvoir, Virginia

Westinghouse Electric Company
Atomic Products Division
Pittsburgh, Pennsylvania

CUBIC AIR TRAFFIC

Cubic Air Traffic

MANUFACTURER

Cubic Corporation

APPLICATIONS

Computer is intended for future air traffic control applications. The computer now is a special-purpose unit, providing 42-target capacity when used with Cubic Corporation c-w tracking equipment. The computer is a special-purpose, magnetic memory-drum variety (used with MOPTAR Cubic multi-aircraft tracking system) which sequentially determines slant range and two direction cosines by phase-mearurement techniques to each of 42 separate airborne targets at the rate of 4 samples (each) per second. Input equipment converts phase information into a series of binary numbers. The computer successively performs, for each input sample, (a) special digital smoothing and filtering operations on each input binary number, (b) ambiguity resolution between overlapping number digits to produce a single range and two direction cosine numbers, (c) computation of aircraft X, Y, and Z position data and (d) conversion and transmission of computed X, Y, and Z positions in IBM 704 format over transmission lines.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20
Arithmetic system	Fixed point
Instruction type	Words handled serially

Arithmetic unit effectively programmed to operate on recirculating data corresponding to particular target sample being handled.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	250	250
Mult	250	250

Construction (Arithmetic unit only)

Transistors	750
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Combination external high-speed multiplier and square-root extractor employed for multiplication and square rooting. Additions performed during drum recirculation.

STORAGE

Medium

Magnetic Memory Drum

Digital filtering requires equivalent of 168 words; ambiguity resolution and coordinate conversion are both performed in temporary storage corresponding to 5 words in length. Drum has 12 recirculating channels of approximately 20,500 bits total.

INPUT

Medium

Input equipment includes special phase-to-digital conversion equipment consisting mainly of flip-flop counters and clocks. Its overall operation is programmed by the memory drum.

OUTPUT

Medium

A Cubic standard unit (Model DH-10) places the computed X, Y, and Z target sample values in IBM 704 format on output transmission lines.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	2,000
Transistors	2,600

Computer itself has 750 transistors, input equipment has 1200 transistors, and the DH-10 output unit has 600 transistors.

CHECKING FEATURES

Data sample is not taken if a poor signal is received form the target. Also, the basic digital filtering technique is self-correcting in the event of intermittent arithmetic failures.

PRODUCTION RECORD

Number on order	1
Time required for delivery	12 months

This computer is intended for future air-traffic control application.

ADDITIONAL FEATURES AND REMARKS

Special-purpose techniques enable this relatively slow, serial memory-drum computer, with external high-speed multiplier, to perform slightly more arithmetic operations per unit time than can be performed by the IBM 709 class of general-purpose computers.

CUBIC TRACKER

Cubic Tracker

MANUFACTURER

Cubic Corporation

APPLICATIONS

All digital computers built by Cubic are Special Purpose Fixed Program Real Time Computers. Two are in operation at PMR. Five are scheduled for delivery to WSMR in September, 1960. One in production for NOTS. Prototype developed and delivered to Eglin A.F.B. Systems are used on line in real-time.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary Digits/word	up to 21
Arithmetic system	Fixed point

There are several modes of operation, each one containing its own program. Arithmetic Section contains 21-bit shift registers plus numerous index registers.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	20	10

Construction (Arithmetic unit only)
Transistors 100 - 2N597, 100 - T1778

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits/word	Access Microsec
Flip-Flops	64	8 - 20	10/bit

Magnetic Tape

No. of units that can be connected	1 Unit
No. of characters/linear inch	200 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	.367 - .7045 Inches
Tape speed	30 - 1.875 Inches/sec
Transfer rate	15 k/s Chars/sec
Width	0.5 Inches

INPUT

Medium	Speed
Flip Flop	96 Kc

OUTPUT

Medium	Speed
Flip Flop	96 Kc

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Use
Diodes		
PSI720	200	Gating
1N276	450	Gating
1N270	600	Gating
Transistors		
2N597	600	Low speed Flip Flop
2N501	600	High speed Flip Flop
T1778	200	Nor Gates
2N385	200	Emitter Follower

CHECKING FEATURES

In the test made of operation all inputs can be simulated and the clock switched to manual.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1 Kw
Power, air conditioner	1 Kw
Volume, computer	200 cu ft
Volume, air conditioner	50 cu ft
Area, Computer	40 sq ft
Area, air conditioner	20 sq ft
Room size, computer	20 x 20
Floor loading	50 lbs/sq ft
Capacity, air conditioner	1 Ton
Weight, computer	2,000 lbs
Weight, air conditioner	1,000 lbs

PRODUCTION RECORD

Number produced to date	7
Number in current operation	2
Number in current production	5
Number on order	5
Anticipated production rates	12/year
Time required for delivery	8 - 12 months

COST, PRICE AND RENTAL RATES

List of Components of Basic System
- Digital phasemeter
- Processor
- Format translator
- Tape handler

List of Additional Equipment
- Co-ordinate Converter
- Test unit

Field services are available.

PERSONNEL REQUIREMENTS

System requires one operator for each 8-hour shift. Training made available by the manufacturer to users includes in plant and field training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

All transistors undergo an aging process.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include reliability and simplicity.

FUTURE PLANS

Computers now in production contain automatic calibration.

CYCLONE

CYCLONE

MANUFACTURER

Iowa State University

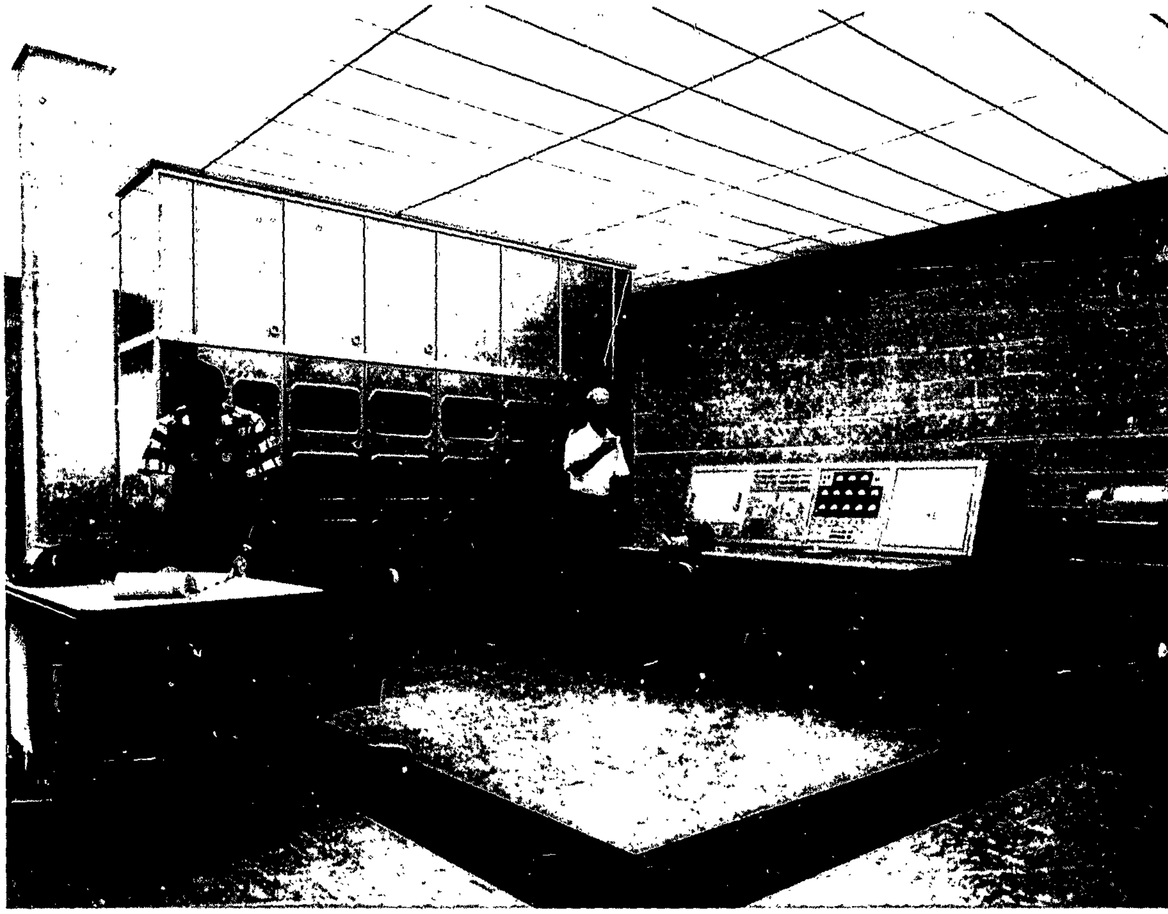


Photo by Iowa State University

APPLICATIONS

Utilized for general purpose computing to support research work on campus.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number of binary digits/word	40
Number of binary digits/instruction	20
Number of instructions/word	2
Total number of instructions decoded	112
To be increased to 152 when modifications are completed	
Arithmetic system	Fixed point (Fractional base)
Instruction type	One address
Number range	

$$-(1 - 2^{-39}) \leq n \leq (1 - 2^{-39})$$

Instruction word format

4 bit basic op	4 bit varient	12 bit address	4 bit basic op	4 bit varient	12 bit address

Automatic built-in subroutines include multiplication.

Automatic coding, assembly program will be completed with machine modification.

Registers include an accumulator register, a multiplier-quotient register, an operand register, and an order register.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec.	Exclud. Stor. Access Microsec.
Add	100 av.	70
Mult	990 av.	960
Div	1200 av.	1170

Construction, arithmetic unit only
Vacuum tubes

Type	Quantity
5844	1,521
7044	386
5670	431
5726	233

Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Williams tube Electro-static	1,024	40,960	30 av.

INPUT

Medium	Speed
Paper Tape - 5 level	300 char/sec

Local Design and construction

OUTPUT

Media	Speed
Paper Tape -5 level	60 char/sec
Model 28 Teleprinter	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
7044	386
6571	40
813	4
6x4	8
5844	1,521
6080	12
6005	61
5726	233
5654	113
C6J/K	18

CHECKING FEATURES

Fixed
- Division error

Optional
- CRO on memory read amplifier
- Single order execution
- Step-wise gating within single order execution

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	19 Kw
Volume, computer	400 cu ft
Area, computer	62 sq ft
Room size, computer	18 ft x 25 ft
Floor loading	150 lbs/sq ft
Weight, computer	5,000 lbs
Capacity, air conditioner	6 Tons

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

Not manufactured for sale.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Analysts			
Programmers	8	12	16
Coders			
Operators	1	2	3
Engineers	1	2	2
Technicians	1	2	2

Training made available to users includes programming classes conducted on a regular schedule.

Operation tends toward open shop.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Good time	40.9 hrs/week av.
Attempted to run time	41.2 hrs/week av.
Operating ratio (good time/ attempted to run time)	0.992

Above figures based on period 1 May to 30 Jun 60. System was placed in operation in Jul 59.

Premium components, all connections soldered. Greatest source of failure is input-output equipment. Anticipated error rate is one error in 40 hours of operation.

ADDITIONAL FEATURES AND REMARKS

The prototype of this machine is ILLIAC, the University of Illinois Digital Computer. Pertinent information on this system will be found under this listing.

FUTURE PLANS

Plans for new components include a 64 word output buffer memory (mag. core) (under construction), a 16,380 word mag. core memory (under construction to replace 1,024 word Electrostatic Williams tube (CRT) memory, and two IBM 726 tape units to be coupled into computer (tape units on hand).

Under consideration are a card reader, a CRT output camera, and a high speed line printer.

INSTALLATIONS

Iowa State University
Ames, Iowa

DATAMATIC 1000

Datamatic 1000 Electronic Data Processing System

MANUFACTURER

Minneapolis Honeywell Regulator Company
DATAmatic Division
Newton 61, Massachusetts

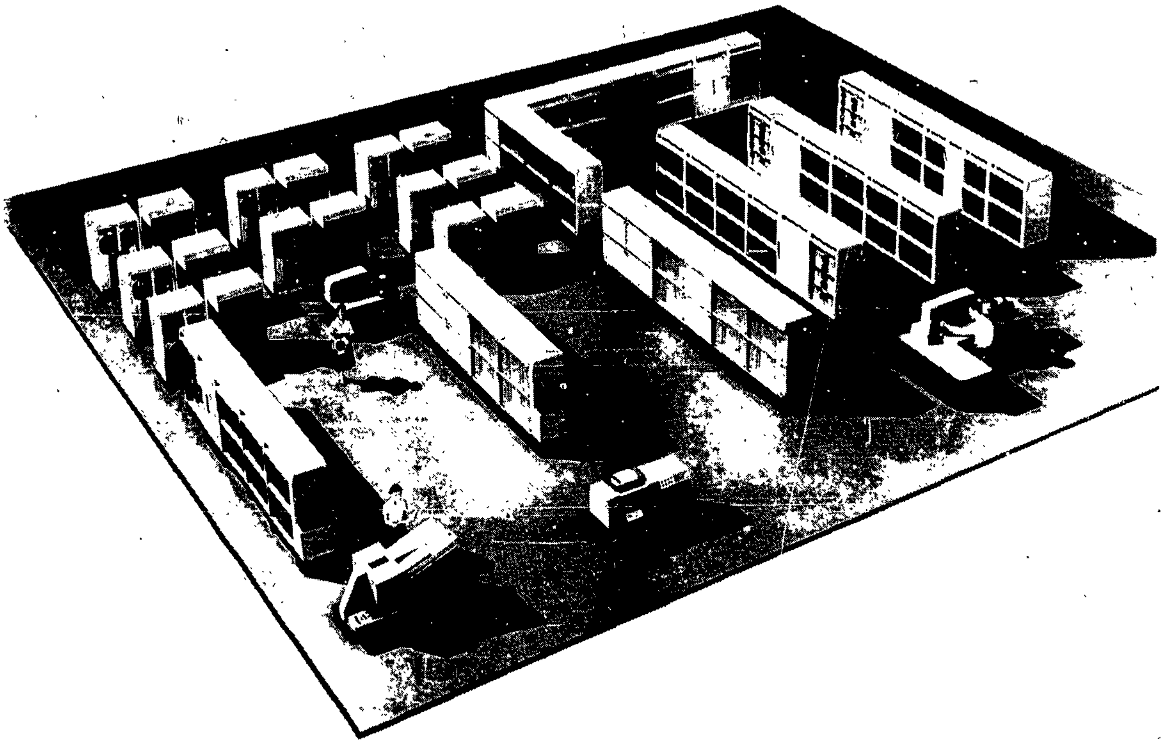


Photo by Minneapolis-Honeywell Regulator Company

APPLICATIONS

Manufacturer

System is designed and used for commercial (business) and scientific applications.

Baltimore & Ohio Railroad Company

Located on the 10th Floor, B&O Central Building, Baltimore, Maryland, the system is used for payroll, freight revenue accounting, and car accounting.

First National Bank of Boston

Located at the Main Office in Boston, Massachusetts, the system is used for Deposit Accounting, Check Reconcilement, and Corporate Trust Accounting including maintenance of stockholders' ledgers, preparation and processing of cash dividends, stock dividends, proxies, addressing mailable materials, stock subscriptions, etc. It is used for Loan Accounting, including factoring (accounts receivable) consumer loans, commercial and real estate loans, revolving Check-Credit loans, etc. Additional applications for the future include Savings Accounting, Payroll, Expense Distribution, Personal Trust Accounting and Safe Deposit Accounting.

Michigan Hospital Service

Located on the 6th Floor at 441 E. Jefferson, Detroit 26, Michigan, the system is used for daily maintenance of subscriber records and verification of hospital and medical benefits, premium billing, premium accounting and statistics, and claim accounting and statistics.

Minneapolis-Honeywell Regulator Co.-TCG Division

Located at 2753 4th Avenue South, Minneapolis, Minnesota, the system is used for payroll, account distribution, accounting ledgers, factory labor efficency, file maintenance, sales statistics, factory scheduling, standard cost calculation, and inventory extension.

Treasury Department

The system is located on the Second Floor at 214 Seventh Street, Parkersburg, West Virginia. Operations are concerned with the issuance and retirement of Series E, United States Savings Bonds in punch card form sold to the public beginning October 1,1957.

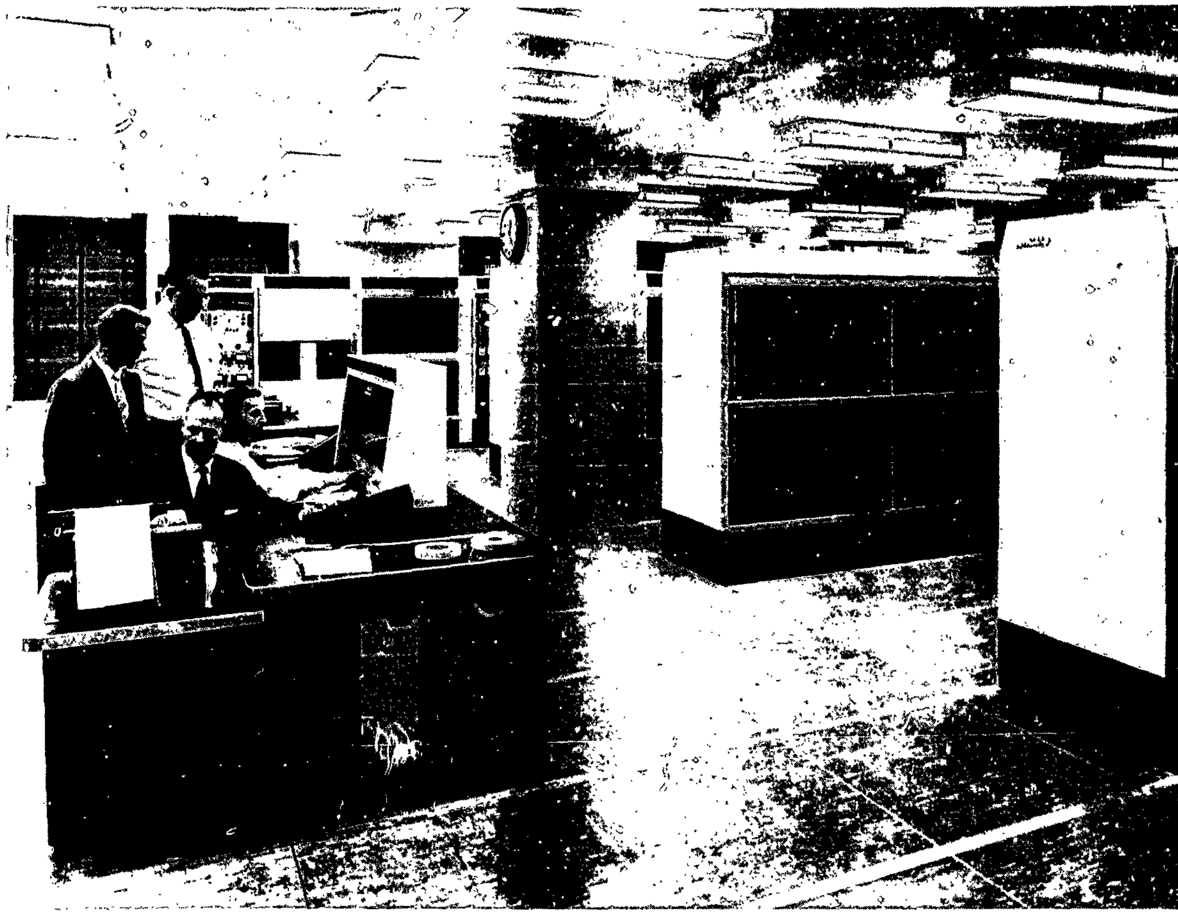


Photo by the First National Bank of Boston

The original bonds and registration stubs are used to prove the accuracy of shipments from issuing and paying agents and establish alphabetic and numeric registration records to provide a status record of every United States Savings card bond printed. Alphabetic files are maintained by the name of the bond owner and numeric files are maintained by bond serial number to reflect the issuance and retirement of each bond. These records serve as search media to answer inquiries relative to card bond holdings and the status thereof. Reports are produced to reflect classified charges to the U.S. Treasurer's account and to provide the Division of Public Debt Accounts and Audit, Washington, with accounting data for the maintenance of outstanding savings bond interest accounts.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal and coded alphanumeric
Decimal digits/word	12
Alphanumeric digits/word	8
Decimal digits/instruction	12
Instructions per word	1
Instructions decoded	1
Arithmetic system	Fixed point
Instruction type	Three address (normal) Four address (subsequence operation)
Number range	0-9, 0-16 and 0-64

Floating point operation may be programmed.

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	230.4	58
Mult	1,008	835
Div	2,304	2,131

Construction: Vacuum tube amplifiers, crystal diodes logic and packaged type construction.

Rapid access word registers	7
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Photo by Baltimore and Ohio Railroad

System is primarily sequential. Transfer of information to and from the high speed storage unit is concurrent. The operation times given above under "Including Storage Access" include checking time. The capacity of the accumulator is 11 decimal digits with sign in addition and subtraction or 22 decimal digits with sign in multiplication and division. Parallel reading and writing of 31 channels on magnetic tape with serial handling of bits comprising each character and word. Access to high speed storage is parallel. Arithmetic operations are serial. Decimal digits are in binary coded decimal, alphanumeric characters are in a six-bit code.

STORAGE

Manufacturer Media	No. of Words	Decimal Digits	Access Microsec
Magnetic Cores	2,000	24,000	12
Magnetic Cores	248	2,976	20

Magnetic Tape

No. of units that can be connected	100 Units
No. of chars/linear inch	600 dec, 400 alpha char/in
Channels or tracks on the tape	31 Channels
Tape speed	100 Inches/sec
Transfer rate	60,000 dec, 40,000 alpha char/sec

Physical properties of tape

Width	3 Inches
Length of reel	2,700 Feet
Composition	Plastic sandwich

Baltimore & Ohio Railroad Company

Medium	No. of Words	No. of Digits/Word
Core	2,000	12 num 8 alpha

First National Bank of Boston

Medium	No. of Words	No. of Digits	Access Microsec
Core	2,000	24,000	28
Michigan Hospital Service			
Magnetic Core	2,000	24,000	28.8/52-bit word
Minneapolis-Honeywell Regulator Co.-TCG Division			
Core	2,000	12	10
Treasury Department			
Ferrite Core	2,000	24,000	Approx. 10
Magnetic Tape	3,100,000	37,200,000	2.5 Min.

The ferrite core storage is internal, the magnetic tape storage is external.

INPUT

Manufacturer

Media	Speed
Punched Cards	900 cards/min (Input Converter)
Paper Tape	10 char/sec (via console)
Keyboard	Manual (via console)
Magnetic Tape	60,000 dec dig/sec (On line tape units)

Baltimore & Ohio Railroad Company

Cards (1200 Input Converter)	900 cards/min

First National Bank of Boston

Punch Cards	900 cards/min

Paper tape is to be added.

Michigan Hospital Service

Cards	900 cards/min
Magnetic Tape	60,000 dig/sec

Input is via card reader to magnetic tape to central processor.

Minneapolis-Honeywell Regulator Co.-TCG Division

Punched Card	900 cards/min

Card editing is possible.

Treasury Department

Paper Tape (Flexowriter)	60 char/min
Cards	900 cards/min

Card data is converted on magnetic tape. Magnetic tape is input to central processor at 60,000 decimal digits/sec.

One reel of tape is 2,700 feet long, 3 inches wide, and can store 37,200,000 decimal digits or 28,200,000 alphabetic characters. Input to the system is punched cards; input to the central processor is magnetic tape or paper tape.

OUTPUT

Manufacturer

Media	Speed
Punched Cards	100/min (Output Converter)
Printing	900 lines/min (Output Converter)
Paper Tape	10 char/sec (via console)
Magnetic Tape	60,000 dec dig/sec (On line tape units)
Character-at-a-Time	10 char/sec (Console Typewriter)
Paper Tape	Input Converter
Paper Tape	Output Converter

Baltimore & Ohio Railroad Company

Media	Speed
1400 Output Converter	800 lines/min
1300 Output Converter (Modified IBM 407)	150 lines/min
1300 Output Converter (Modified IBM 519)	100 cards/min

First National Bank of Boston

Printed Page (160 characters/line, 2 printers)	900 lines/min
Printed Page (120 characters/line, 1 printer)	150 lines/min
Cards	100 cards/min

Michigan Hospital Service

Magnetic Tape	60,000 digits/sec
Printed Page	900 lines/min

Anelex high speed printer at 120 char/line.

Minneapolis-Honeywell Regulator Co.-TCG Division

Printed Page	900 lines/min

Printer has 120-160 char/line, 55 characters

Printed Page	150 lines/min

Printer has 120-120 char/line, 47 characters

Cards	100 cards/min

Treasury Department

Magnetic Tape	60,000 dec dig/sec
Punched Card	100 cards/min
Printed Page	900 lines/min

The output of the central processor is on magnetic tape only. The data on the tape is printed and/or punched "off line".

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Tubes	3,600
Tube types	Type 6145 and other computer quality types
Crystal Diodes	60,000
Magnetic Cores	117,000
Transistors	500

The above figures are for the Central Machine.

Separate Cabinets 10 Types (building block units)

Size of installation is dependent on application. Up to 100 magnetic tape units may be used in on-line operation.

CHECKING FEATURES

Manufacturer

Every word contains checking digits. Transfer weight count check. Arithmetic weight count check. Special circuit checking. Selection and order verification checking.

Blank column and multiple punch column detection is under control of the operator of the Input Converter.

Marginal checking circuitry included in addition to the above.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	94.6 Kw	110 KVA	0.86 pf
Power, air cond.	49.2 Kw	60 KVA	0.82 pf
Area, computer		550 sq ft	
Floor loading	Less than 125 lbs/sq ft		
Weight, computer		70,000 lbs	

Air conditioner is built in. No user requirements.

The above weight and power figures include 10 magnetic tape installations. Space figure excludes aisles and work areas. The total is 4,500 sq ft.

The clear space to ceiling is 8 ft. 3 in.
Recommended floor space 40 by 100 feet (for minimum installation).
Voltage requirements - 208 volts, 3 phase, 60 cycle.

Baltimore & Ohio Railroad Company

Power, computer	230 KVA	
Volume, computer	67,500 cu ft	
Area, computer	7,500 sq ft	
Floor loading	60 lbs/sq ft	
	50 lbs/sq ft	
Weight, computer	123,000 lbs	

Site is prepared with perforated metal false ceiling. Plenum between false and building ceiling, false floor - 2 ft x 4 ft sections made of aluminum honeycomb, power distribution units supplied by manufacturer. Air conditioning (chilled water) installed for 70°F. ± 2°F.

First National Bank of Boston

Power, computer	160 Kw	200 KVA	0.8 pf
Power, air cond.	40 Kw	44 KVA	0.9 pf
Volume, computer		6,065 cu ft	
Volume, power room		825 cu ft	
Volume, air conditioner		60 cu ft	
Area, computer		945 sq ft	
Area, power room		200 sq ft	
Area, air conditioner		20 sq ft	
Room size, computer		5,[illegible]25 sq ft	
Room size, power room		[illegible]00 sq ft	
Room size, air condition		95 sq ft	
Floor loading		22 lbs/sq ft	
		125 lbs concen max	
		35 lbs/sq ft power room	
Capacity, air conditioner		15 Tons	
Weight, computer		170,300 lbs	
Weight, power room		22,000 lbs	
Weight, air conditioner		3,065 lbs	

Site preparation included a 15-ton air conditioner for magnetic tape room (including circulating water supply), false floors and partitions for three rooms (MFU, CPU, and converters) and an independent power supply.

Michigan Hospital Service

Power, computer	184 Kw	200 KVA	0.8 pf
Volume, computer		5,700 cu ft	
Area, computer		4,450 sq ft	
Floor loading		24 lbs/sq ft	
		710 lbs concen max	
Capacity, air conditioner		64 Tons	
Weight, computer		106,400 lbs	

Air conditioning system packaged units include 35 tons built into computer, 16 tons for Tape File Room, 8 tons for High Speed Printer and Personnel, and 5 tons for Personnel in Central Processor.

The site has a dropped metal pan ceiling with sound proof bats in each pan. This ceiling is not used as an air condition plenum. The building is of steel and concrete construction. Power for the Data Processor is located on the roof of the building together with the motor generators, electrical panels, compressors, vacuum pump, and individual water tower. The compressors are situated on the 6th floor of the building. Power, water, and air lines come from the 8th floor to the ceiling of the 5th floor. All such lines are suspended from the ceiling of the 5th floor and stub up through the concrete floor wherever necessary to feed the individual units. A free floor was designed and installed to cover all signal wires. Air conditioning is by package units which feed through ducts above the pan ceiling to various outlets. Package air conditioning units are equipped with steam to be used for either heating or humidity control.

Minneapolis-Honeywell Regulator Co.-TCG Division

KVA, computer	200
Volume, computer	62,000 cu ft
Area, computer	5,900 sq ft
Room size	5,900 sq ft
Floor loading	125 lbs/sq ft
	40 lbs concen max
Capacity, air conditioner	35 Tons
Weight, computer	110,000 lbs

Each unit is self cooled. False ceiling is installed for appearance. Power central setup to provide stable power. Power is 208 volts, 3 phases, 4 wire, 60 cycles.

Treasury Department

Power, computer	170.44 Kw	213.05 KVA	0.80 pf 208V.
Volume, computer		9,751 cu ft	
Volume, air conditioner		891 cu ft	
Area, computer		1,513 sq ft	
Area, air conditioner		270 sq ft	
Room size		8,400 sq ft	
Floor loading		101 lbs/sq ft	
		267 lbs concen max	
Capacity, air conditioner		45 Tons	
Weight, computer		153,250 lbs	

Total includes built in air conditioning
Weight, air conditioner 8,175 lbs
Total includes 3 separate air cinditioning units

Site preparations were made at the time the building was erected. The building is of brick and concrete construction with steel girders and concrete floors. Special features in the area include: false flooring; glass enclosures for the input-output converter room, central processor room, magnetic file room, and engineers' room; inter-com system between four areas; dehumidifiers in the magnetic file room; air and water ducts; acoustical tile ceiling for all rooms; power ducts to all rooms from central power room; and air conditioning for the area.

COST, PRICE AND RENTAL RATES

Baltimore & Ohio Railroad Company

1	Model 1000 Central Processor	$21,500/mo.
12	Model 1100 Magnetic File Units	10,800/mo.
3	Model 1170 File Switching Units	570/mo.
1	Model 1200 Input Converter, with card reader	3,325/mo.
1	Model 1300 Output Converter	1,800/mo.
1	Model 1400 Output Converter, including high speed printer	3,500/mo.
1	Model 1900 Central Power	1,750/mo.
		$43,245/mo.

Additional equipment includes IBM 407 at $800/month and IBM 519 at $944/month.

First National Bank of Boston

For the equipment listed, the total monthly rental is $43,475.

Michigan Hospital Service

	Monthly Rental
One Central Processor	$21,500
Eight Magnetic Tape Units	7,200
One Card Reader and Input Converter	3,325
One File Reference Unit	550
One Output Converter and High Speed Converter (Including maintenance)	3,500
	$36,075

Minneapolis-Honeywell Regulator Co.-TCG Division

Quantity	Model	Unit	Purchase Price	Monthly Rental One Shift
1	1000	Central Processor including High-Speed Memory Arithmetic-Control Units Input and Output Buffers Read-Write Unit Central Console Unit Air Conditioning	$985,000	$21,500
11	1100	Magnetic File Unit including Amplifier Unit	660,000	14,850
2	1170	File Switching Unit	19,200	380
1	1200	Card Input System including 900-card-per-minute Card Analyzer and Converter Control Unit	185,000	3,325
1	1300	Output Converter Control Unit	100,000	1,800
1	1310	Adapter for 150-line-per-minute printer (used with Model 1300 Output Converter Control Unit)	13,000	200
1	1320	Adapter for 100-card-per-minute punch (used with Model 1300 Output Converter Control Unit)	1,900	35
1	1400	Output Printing System including 900-line-per-minute printer and Converter Control Unit	215,000	4,300
		Total	$2,179,100	$46,390

Maintenance service contract is $20,000 month (Purchased).

Treasury Department

Installation of the DATAmatic System	$87,777
Components:	
Central Processor	
Auxiliary Central Processor	
16 Magnetic File Units	
4 File Switching Units	
3 Card Input Systems	
Converter Control Unit, Low Speed	
IBM 519 Summary Punch	
Output Printing System, High Speed	
Power Room installation and equipment	8,035
Cost of False Flooring	39,740
Approximate Installation Cost	$135,552
176 Hours, Basic Monthly Rental Charge:	
Central Processor	$21,500
Auxiliary Central Processor	3,900
16 Magnetic File Units at $1,350	21,600
4 Switching Units at $190	760
3 Card Input Systems at $3,325	9,975
Converter Control Unit, Low Speed	535
IBM 519 Summary Punch	144
Output Printing System, High Speed	4,300
Basic Monthly Rental	$62,714
Excess Use Time per Month:	
Central Processor at $61.08/hour	$20,161.80
Auxiliary Central Processor at $11.08/hour	3,711.80
16 Magnetic File Units at $3.84/hr	6,566.40
4 Switching Units at $.54/hour	115.56
3 Card Input Systems at $9.45/hour	132.30
Output Printing System at $12.22/hr	2,566.20
Average Excess Use Time Cost per Month	$33,254.06
Basic Cost	$62,714.00
Excess Use Time Cost	33,254.06
Total Approximate Monthly Cost	$95,968.06

System maintenance and service are included in the monthly rental charge. Power room maintenance and service are covered under a separate contract which averages $4,000 annually.

PERSONNEL REQUIREMENTS

Baltimore & Ohio Railroad Company

	One 8-Hour Shift
Supervisors	5
Analysts and Programmers	35
Librarians	1
Operators	4

Operation tends toward closed shop.

Methods of training used includes a combination manufacturer's formal sessions and informal on-job training.

First National Bank of Boston

	One 8-Hour Shift
Supervisors	1
Analysts	5
Programmers	11
Coders	2
Clerks	3
Operators	2
In-Output Oper	6
Tape Handlers	2

Methods of training used includes 4 weeks in manufacturer's school and on-the-job training.

Michigan Hospital Service

	One 8-Hour Shift
Supervisors	1
Analysts	3
Programmers	12
Clerks	2
Operators	1
In-Output Oper	2
Tape Handlers	1

Operation tends toward open shop.

Methods of training used includes programming training by Minneapolis-Honeywell and operator training by Michigan Hospital Service (detailed operating instructions).

Minneapolis-Honeywell Regulator Co.-TCG Division

	One 8-Hour Shift	Two 8-Hour Shift	Three 8-Hour Shift
Supervisors	1	1	1
Programmers	17	17	17
Clerks	4	4	4
Librarians	1	1	1
Operators	2	4	5
Engineers	3	5	7
In-Output Oper	2	4	6
Tape Handlers	1	2	3

Operation tends toward open shop.

Methods of training used

Six weeks programming course for analysts and programmers.

Operation 3 weeks on-the-job

Console 6 weeks on-the-job

Treasury Department

	One 8-Hour Shift Used	One 8-Hour Shift Recomm	Two 9-Hour Shifts Used	Two 9-Hour Shifts Recomm
Supervisors	2		4	
Analysts	2	3	-	
Programmers	14		-	
Coders	-		-	
Clerks	6		3	
Librarians	1		2	
Operators	-		5	6
Engineers	-		~~-~~	
Technicians	1		-	
In-Output Oper	-		8	8
Tape Handlers	-		4	6

Operation tends toward open shop.

One DATAmatic representative is assigned full time for guidance in the programming activities and the operations of the system. Periodically, special training courses are conducted by the DATAmatic Corporation either at the site or company location. On-the-job training is given continuously to peripheral equipment and console operators.

Personnel listed under the two 9-hour shifts are assigned to the Electronic Data Processing Section which is responsible for the scheduling of machine time and operation of the electronic equipment. Programming is one of the activities of the Methods and Procedures Section. This staff performs all planning, programming and checking out of the routines to place them in an operational state and provides all operating instructions necessary for successful performance. This group of employees operates on an 8-hour basis but each individual programmer is on 24-hour call.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Baltimore & Ohio Railroad Company

Good time 42.3 Hours/Week (Average)
Attempted to run time 45 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period Feb 60 to Mar 60
Passed Customer Acceptance Test Mar 59
Time is available for rent to qualified outside organizations.

First National Bank of Boston

Good time 39.5 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98+
Above figures based on period Jul 58 to 31 Mar 60
Passed Customer Acceptance Test Jul 58
Time is available for rent to qualified outside organizations.

Time is rented to Datamatic Service Bureau (1 full shift).

The operating ratio is approximately the same for the Service Bureau.

Michigan Hospital Service

Average error-free running period 4.9 Hours
Good time 53.3 Hours/Week (Average)
Attempted to run time 58.2 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.916
Above figures based on period 1 Jan 60 to 6 Aug 60
Passed Customer Acceptance Test 1 Mar 58
Time is available for rent to qualified outside organizations.

Use by outside organizations is arranged through Minneapolis-Honeywell Regulator Company, DATAmatic Division.

Minneapolis-Honeywell Regulator Co.-TCG Division

Good time 92 Hours/Week (Average)
Attempted to run time 100 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.92
Above figures based on period 1 Jul 59 to 1 Jul 60
Passed Customer Acceptance Test 1 Jul 59
Time is not available for rent to outside organizations.

Treasury Department

Average error-free running period 8.2 hours per 9 hour shift
Good time 115 Hours/Week (Average)
Attempted to run time 126 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.913
Above figures based on period 1 Apr 60 to 30 Jun 60
Passed Customer Acceptance Test 1 Nov 58
Time is not available for rent to outside organizations.

The operating ratio is based on a 7 day week, two 9-hour shifts a day.

ADDITIONAL FEATURES AND REMARKS

Baltimore & Ohio Railroad Company

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include generation of labels in computer program used for tape assignment, tape storage in closed file-type cabinets, and air-conditioned atmosphere for humidity and temperature control.

First National Bank of Boston

Outstanding features include exceptional reliability, very high error-free recording, and recovery of information on magnetic tapes. Unique system advantages include high capacity of tapes, 465,000 punched cards per tape (reel), high speed, simultaneous read/write (60,000 digits/sec.), and ability to edit on off-line converters, saving CPU time.

Michigan Hospital Service

Outstanding features include large storage capacity of magnetic tape (37,200,000 digits per reel), read/write magnetic tape at 60,000 digits per second, and three address instruction system (simplifies programming).

Unique system advantages include system and instructions designed for data processing, particularly for low activity updating of large record files.

Tape reels are numbered with ink marking pen. Data is labelled with Labelon Tape. Tape room is controlled for temperature, humidity, and dust. Security Tapes are stored in first floor lobby for 24 hour period. Security Tapes are alternated in warehouse storage on a semi-monthly basis.

Minneapolis-Honeywell Regulator Co.-TCG Division
Outstanding features include 3" wide tape, orthotronic control, 900 lines per minute printing speed. Tape storage is dust, humidity and temperature controlled. A distant vault is used for backup tapes.

Treasury Department
Outstanding features are (1) Transfer rate of 60,000 decimal digits per second; (2) efficient and speedy sorting; (3) searches 10 tapes at once at transfer rate of 600,000 decimal digits; (4) "OFF LINE" input and output; (5) built in air conditioning for central processor.

Unique system advantages include (1) ability to read and search forward and backward and (2) Modulo 9 weight count checking system.

Adopted procedure for magnetic tape labelling, storage, shipping and protection from humidity, temperature and physical, electrical, fire, or other damage include:

Tape Labelling
Reels are labeled with color code, name and run number(s). Dates, names and run codes are written on tape.

Storage
Active tape records are stored on shelves in the Magnetic File area. Security tapes are stored in a vault in another building.

Shipping
Reels are placed in plastic bags and boxed in corrugated cartons cushioned with fillers.

Protection from Humidity, Temperature, etc.
Air conditioning and normal protection.

The tape utilized in this System is divided into 36 linear recording channels. 31 of these channels are used for storing information. All other channels are used for control purposes. Data is arranged along the 31 information channels in arbitrary units called words and blocks. Each block contains a total of 62 information words. There are 52 bits in a word. Four are used for checking purposes and the remaining 48 may represent either numeric or alphabetic data. A word may be made up of 12 four-bit decimal digits, 8 six-bit alphabetic characters or any combination of these adding up to 48 binary digits.

FUTURE PLANS

First National Bank of Boston
There is a tentative plan to switch to Honeywell H-800 in 1962, when a third high-speed printer, a high-speed paper tape input, and high-speed MICR input (2 systems) will be added.

Treasury Department
Present plans are to carry out the program relating to punch card U. S. Savings Bonds established at the inception of the system, all available machine time is required. Plans are in a formulative stage to include the processing of Series E paper bond retirements abd reissue transactions as machine time is made available through improved programming techniques and liquidation of the backlog which antedates installation of the equipment.

INSTALLATIONS

The Baltimore and Ohio Railroad Company
B&O Central Building
Baltimore 1, Maryland

The First National Bank of Boston
67 Milk Street
Boston, Massachusetts

Michigan Hospital Service
441 E. Jefferson
Detroit 26, Michigan

Minneapolis-Honeywell Regulator Co.-TCG Division
2753 4th Avenue South
Minneapolis 8, Minnesota

Datamatic Division
Minneapolis-Honeywell Regulator Company
60 Walnut Street
Wellesley Hills, Massachusetts

Treasury Department
Bureau of Public Debt
214 Seventh Street
Parkersburg, West Virginia

DE 60

Clary Model DE 60 Computer

MANUFACTURER

Clary Corporation

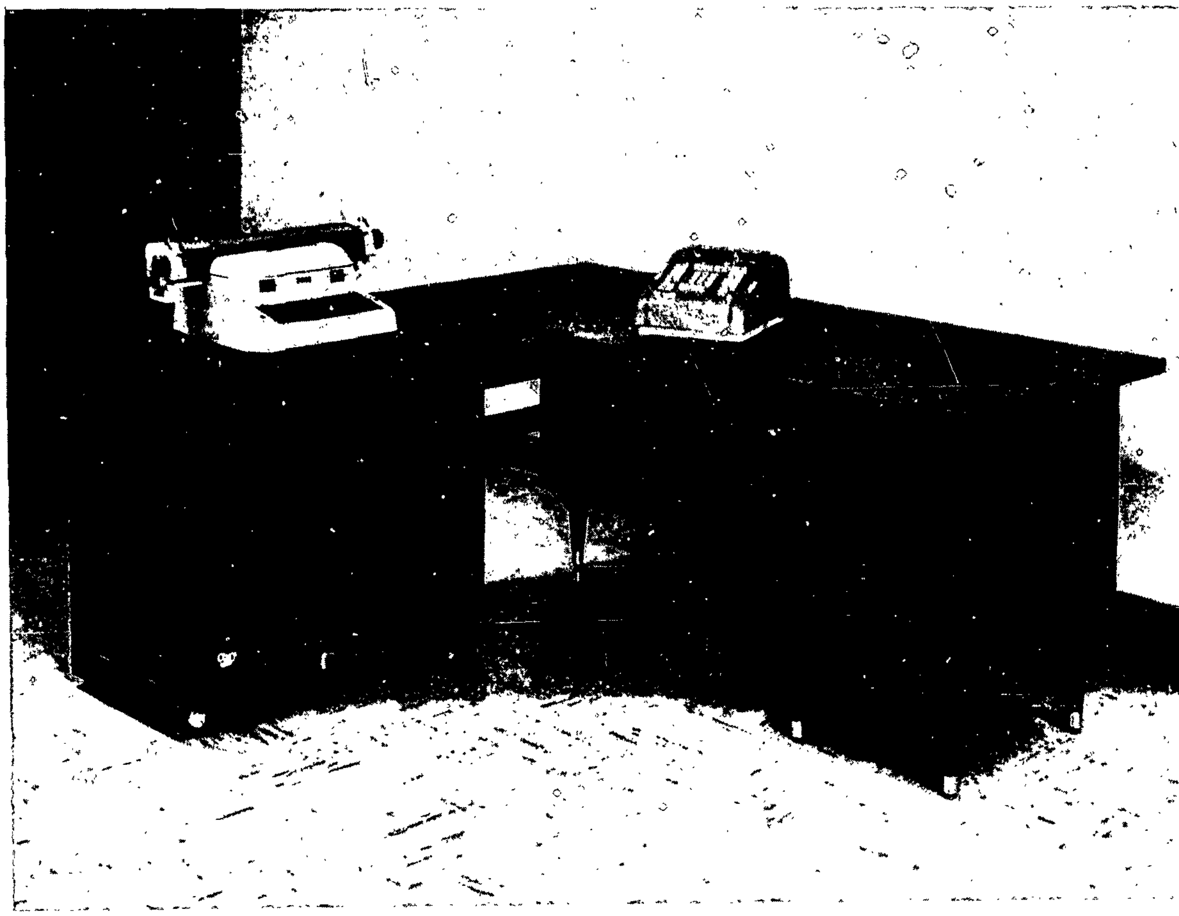


Photo by Clary Corporation

APPLICATIONS

System is designed for general purpose, scientific, engineering, commercial, on-line, and real time uses.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Decimal digits/word	18 and sign

System is externally programmed.

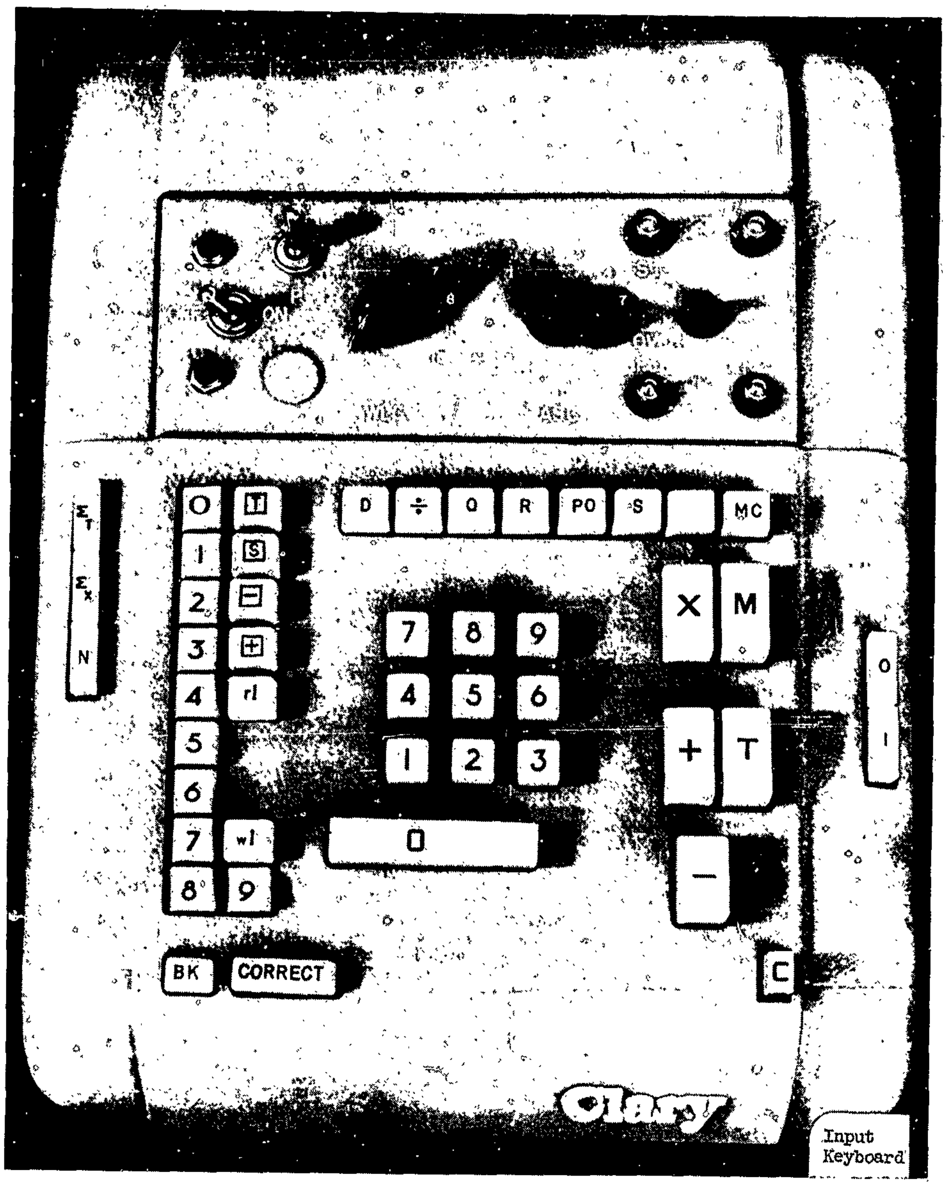
Instructions decoded	37
Arithmetic system	Fixed point (to right of word)
Instruction type	Multiple address (up to five) and multiple operations/instruction
Number range	Less than 10^{18} and equal to or greater than 0.

Instruction word format

Source	Operation	Destination	Format (Output)
(one source)	(up to four)	(up to four)	Print, Word Length, Decimal Point

Automatic built-in subroutines are contained in a plug-in catrridge. Any standard function ($\sqrt{}$, sin, cos, e^x, etc.) may be obtained. Special subroutines are furnished to customers' specifications.

Registers include multiplicand, dividend, quotient, remainder, registers and a special register to retain last operand used.



Input Keyboard

Photo by Clary Corporation

ARITHMETIC UNIT

Operation	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	60,000	3,000
Mult	200,000 (Avg)	140,000
Div	220,000 (Avg)	160,000

Time includes access to 5 addresses and automatic alignment (shifting) of decimal point.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Microsec
Drum	32	576	7,500 (Avg)

Capacity may be expanded to 160 words (5120 digits) in units of 16 words. Access time will be unchanged.

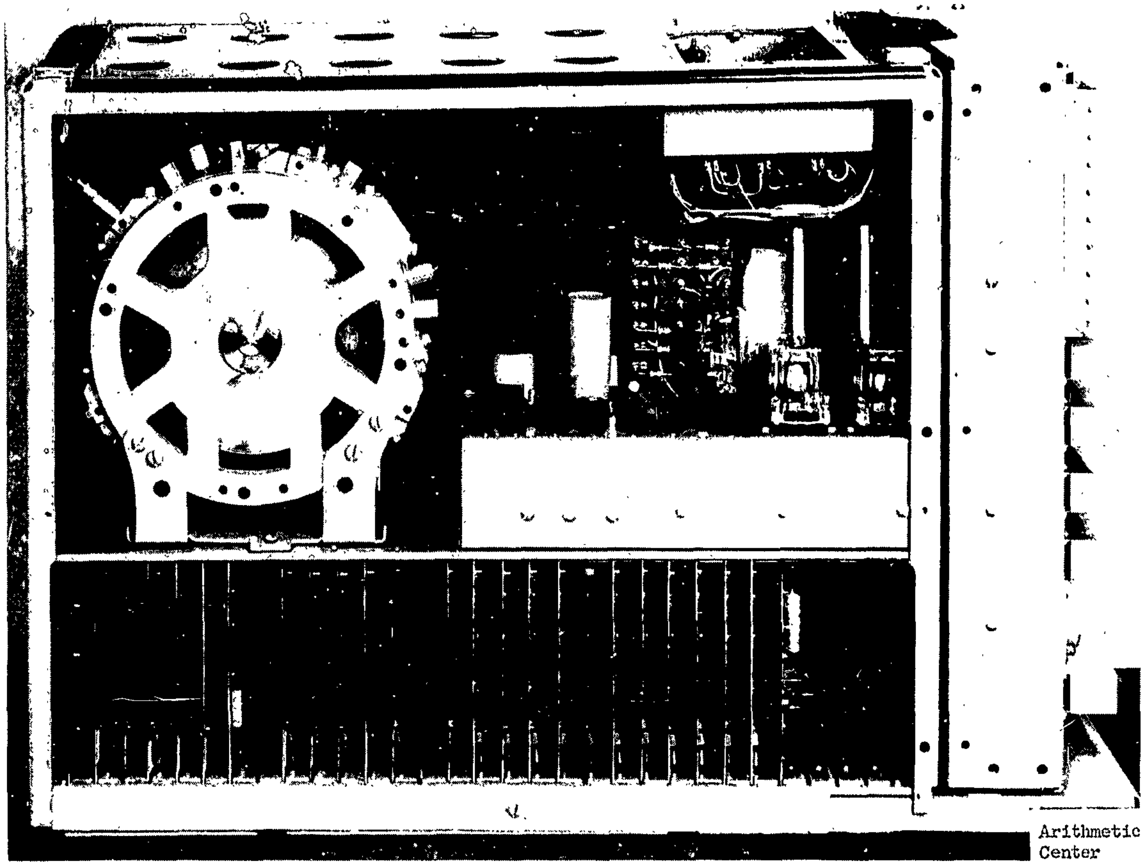


Photo by Clary Corporation

INPUT

Media	Speed
Keyboard	Manual
Paper Tape	20 char/sec
Punched Cards	20 col/sec
On-line Equipment	

Except for Keyboard, above equipment is optional or engineered to meet requirements.

OUTPUT

Media	Speed
Printer	20 char/sec 10 char/line
Typewriter	10-15 char/sec
Paper Tape	20 char/sec
Punched Cards	20 col/sec

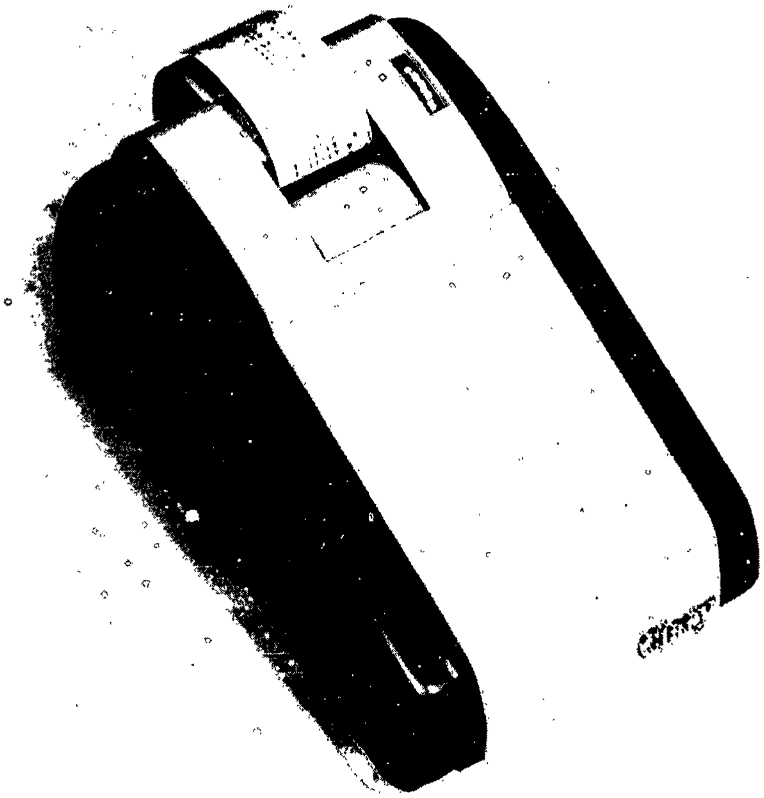
Speeds are limits of peripheral equipment, not the computer. Except for Printer, above equipment is optional.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
Thyratrons	14
Diodes	2,000
Transistors	200

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.15 Kw
Volume, computer	76.5 cu ft
Area, computer	25.5 sq ft
Room size	8 ft x 8 ft
Weight, computer	300 lbs



Line Printer

Photo by Clary Corporation

PRODUCTION RECORD

Number produced to date	9
Number in current operation	9
Number in current production	10
Number on order	8
Anticipated production rates	4 - 10 months
Time required for delivery	3 Months

COST, PRICE AND RENTAL RATES

Description and Price
Standard Clary Computer Model DE-60

1 Arithmetic center - 6102 and 6202
1 Input - 6302
1 Output - 6402
1 Desk - 6602.01 and 6702.01
1 Programmer - 6502.01 (including one cartridge of customer's choice)
2 Plugboards with wires - 6802
$18,000.00 ex-factory San Gabriel, plus all applicable taxes.

90 days delivery, unless otherwise provided.

Optional and Additional Equipment

IBM or Remington Rand typewriter output (20" carriage standard) in lieu of standard output 6402, $2,000.00

Punch Tape output (in addition to standard output 6402), $2,000.00

Additional standard cartridges $45.00 (Square root, log, antilog, power series, sin, cos, plus others as they become available).

Custom cartridges $2.50 per step.

90 days delivery for typewriter equipped models.

Contract Terms

Purchase Plan

Prices are ex-factory San Gabriel, plus all applicable taxes.

Ninety (90) day free service and parts warranty.

After first 90 days, service contract available as follows:

Within 50 miles of service facility 3% of purchase price per year, plus parts.

Over 50 miles from service facility 3% of purchase price per year, plus actual round trip travel expense, plus $10.00 per hour for time actually spent by each member of service group to and from location, plus parts.

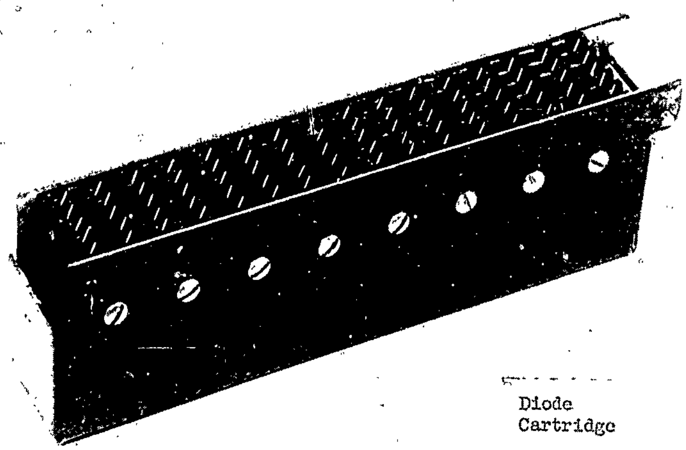


Photo by Clary Corporation

Lease Plan

Minimum lease period contract three (3) years.

Monthly lease price, payable in advance, 3 1/2% of purchase price per month, including service. Ninety day warranty from installation date for parts. If unit is located over 50 miles from service facility, customer pays actual round trip mileage additional, plus $10.00 per hour for time spent by each member of service group for travel time to and from location.

After three (3) year initial period, lease may be renewed annually as follows:

1. Within 50 mile radius of service facility, 1% of purchase price per month, including service plus parts.
2. Over 50 mile radius, 1% of purchase price per month plus actual round trip mileage, plus $10.00 per hour for actual time spent by each member of service group traveling, plus parts.

Rental Plan

Minimum rental period twelve (12) months.

Monthly rental is 3% of purchase price per month, payable in advance, including service and parts if located within 50 mile radius of service facility. If located over 50 miles from service facility, customer pays actual mileage expense of service personnel, plus $10.00 per hour per man for time spent traveling to and from location.

Sixty (60) day minimum cancellation notice required after contract period expires.

In the event customer elects to purchase within two years after renting, 50% of first year's rental and 40% of second year's rental may be applied toward the purchase price.

PERSONNEL REQUIREMENTS

System may be used for "open shop" operation with no permanent personnel assigned.

Training made available by the manufacturer to users includes programming and operating instruction at no charge. A two week maintenance and repair course is given at no charge. A six week maintenance and repair course is given at a charge of $600.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by the manufacturer to insure required reliability includes modular construction, and plug-in components. Experience shows 96.5% - 99.9% uptime.

ADDITIONAL FEATURES AND REMARKS

System is easy to use and program, may be used manually as a high speed claculator or under automatic control. Large words for high accuracy are used. Completely decimal with no conversion routines necessary, small size and low power requirements (150 watts), and no cooling are additional features. System is complete and small enough to fit right into an office without special site preparation. Computation may then be done by the originator at his location.

DIANA

LFE Diana Computing System

MANUFACTURER

Laboratory for Electronics, Incorporated

APPLICATIONS

System is designed for general purpose business applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	Variable word and block length
Decimal digits/instruction	10
Instructions per word	1
Instructions decoded	20
Arithmetic system	Fixed point
Instruction type	Two address (Source and destination)
Number range	Alphanumeric: 0 to 99 characters per word for computing up to 12 places

Instruction word format

V	W	X	Y	Z	D	d	O	P	(sign)

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	560	186
Mult	3,137	2,577
Div	4,830	4,270

Construction (Arithmetic unit only)
Magnetic Cores

Arithmetic mode	Parallel
Timing	Synchronous (Excepting File Drums)
Operation	Sequential and Concurrent

The operation times given above for addition and multiplication are for the number 999,999 as operands. The divide time is for a 5 digit quotient. Computer operations are mainly sequential. Input-output operations are concurrent with computation. The arithmetic unit may also work concurrently with non-arithmetic operations. Non-arithmetic operations may be performed concurrently during the last 113 microseconds of the addition time, during the last 2,265 microseconds of multiplication, and during the last 3,966 microseconds of division.

The arithmetic unit consists of the product, multiplier, and multiplicand registers. These registers are 13 digits in length, with character position 0 holding the sign and character position 12 holding the most significant character.

Since the system is capable of handling British sterling notation, the adder, which is part of the arithmetic unit, operates in sterling notation if digit d of the addition, subtraction, multiplication, and round instructions is not a zero. In this case, scale of 10 operation is specified. Multiplication is accomplished by halving the multiplier and doubling the multiplicand, with the contents of the multiplicand register being added to the contents of the product register each time the number in the multiplier is odd. On the whole, this method of multiplication is faster than one involving successive additions. Division is accomplished by repeated subtraction of the divisor from the dividend, with the dividend initially in the multiplicand register and the divisor in the multiplier register. The quotient appears in the multiplicand register and the remainder in the product register.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	Variable	200 - 10,000	34
Hi-Speed Drum	Variable	58,500	11,000
File Drums	Variable	$(1.875\text{-}652) \times 10^6$	197,000
Magnetic Tape			

Access times given above include drum switching. The high speed drum rotates at a speed of 100 revolutions per second, recording is performed in parallel and includes 6,000 characters of input-output buffers.

The file drum rotates at 3 revolutions per second, recording is serial. Each file drum has a capacity of 15×10^6 bits. Characters may be alphanumeric or numeric only. The magnetic file drum is the bulk storage medium. It is 15 inches in diameter by 15 inches long, having a capacity of 1,875,000 alphanumeric characters or 2,500,000 numeric characters. Any number of these file drums (up to a maximum of 330) can be used in a given installation, and regardless of how many are used, the average random access time to any part of the entire file remains one-sixth of a second. For intermediate and buffer storage a single high-speed drum is used, having a capacity of 58,500 alphanumeric characters and an average random access time of 10 milliseconds.

Internal working storage (OAST) consists of from 200 to 10,000 characters of magnetic core storage with an average access time of 34 microseconds. In addition, there are twelve transfer registers, each with magnetic core storage for 10 alphanumeric characters.

Since the storage capacity of the magnetic file drums and of OAST is scalable, a user need acquire only the capacity required by his application. This factor, together with a choice of the type and quantity of input and output devices, provides a flexible system that can be tailored to the individual requirements of any given application.

File drums are grouped into units of from one to 33 drums per unit (actually from 300 to 10,000 tracks per unit, which, at 300 tracks per drum, would be a maximum of 33 1/3 drums per file drum unit.) The maximum number of file drum units in a given installation is 10. Both the number of file drums per unit and the number of units are determined by the requirements of the application for which the system is intended.

Each file drum unit contains its own reading and writing mechanism and track selection devices. In locating a record in a file drum unit the computer must first select the proper track by placing the track number in the track address register. The track number may be wholly contained in the record number (tag), or it may be found on an index track which relates record numbers to the appropriate track numbers.

Transfers from a file drum unit can be in the form

of a block transfer to OAST, or a word or character transfer to the arithmetic unit or one of the transfer register. Multiple-block transfer to OAST are also possible, provided OAST is large enough. Information can be transferred from one file drum unit to another, a track at a time. If the installation includes a magnetic tape unit, information can also be transferred from a file drum unit to tape, a track at a time.

Information can be written on the file drum in only three ways: by a block transfer from OAST, by a track transfer from another file drum unit, or by a track transfer from magnetic tape. During track transfers in either direction, the computer may perform other operatio s which do not require the use of the drums. The time required for a track transfer is 0.6 second. One drum, therefore, can be loaded or unloaded in three minutes.

On the file drums, information is stored in serial by bit fashion. On the magnetic tape it is stored in parallel by bit, serial by character fashion. The high speed drum serves as an intermediate speed general storage for the computer and in addition contains the input-output buffers. This drum sets the system pulse repetition frequency of 150 kc by means of an engraved clock track. A second clock track is used in locating sectors on the drum. This sector clock track has 20 equal divisions which are used to locate the 20 sectors of any given band. The use of bands (adjacent tracks in groups of 7) permits parallel by bit handling of handling of characters and a 150 kc frequency. The capacity of this drum can be specified for each system arrangement.

Magnetic Core Storage (OAST, Transfer Registers)

OAST has a maximum size of 10,000 characters arranged into 100 sectors of 10 decades per sector, 10 characters per decade. Its minimum size is two sectors or 200 characters. Information is located by sector, decade, and character position, or by sector and word number. Data is handled in parallel by bit, serial by character at a character frequency of 150 kc. The maximum access time to any characters is 9 bit times or 60.3 microseconds (the time required to move from the first to the last character in a decade.)

Information recorded in OAST wipes out the previous characters, while that read from OAST is retained in storage by recirculation of the characters. In a single-block transfer to OAST, the most significant character of the block transferred is placed in the zero position of the decade addressed. In a multiple-block transfer to OAST, the most significant character of the first block transferred is placed in the zero position of the decade addressed; following blocks are written densely. The number of blocks to be transferred is specified in the instruction.

INPUT

Media	Speed
Paper Tape	300 char/sec
Typewriter	Manual

OUTPUT

Media	Speed	
Paper Tape	60 char/sec	
Line Printer	150 lines/min	ICT 915

Many different types of input-output equipment may be used simultaneously, each working concurrently with the others and with the computer.

Information to be processed or stored can be entered into the system in a number of different ways; via punched paper tape, punched cards, direct keyboard or in certain cases, via magnetic tape. Output can be via punched paper tape, punched cards, line printer, direct typewriter cathode ray tube viewer, or in certain cases, magnetic tape. The magnetic tape input and output units are more in the nature of drum loading and unloading devices; they are used chiefly to store information to which random access is not currently required, or to provide duplicate storage for security purposes. The International Computers Tabulators Model 915.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
8 types	1,300
Diodes	
6 types	62,000
Magnetic Cores	
2 types	15,000

Above information is based on the ICT computer

CHECKING FEATURES

Single bit errors are detected in all information and control paths except in the arithmetic unit. This includes input-output paths, and all data on the addressed file drum track.

Dual (parallel) arithmetic unit. If the dual arithmetic unit is not included, arithmetic operations can be checked by program.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	90 Kw
Volume, computer	12,000 cu ft
Area, computer	1,200 sq ft
Room size	30 ft x 40 ft
Floor loading	200 lbs/sq ft
	250 lbs concen max
Weight, computer	20,000 lbs

3 phase, 115V ac, 60 cycles/sec.

PRODUCTION RECORD

Number produced to date 1

INSTALLATIONS

This computer is now installed operating at The International Computers Tabulators, facilities in England.

DIGITRONIC CONVERTER

Digitronics Converter Data Processor

MANUFACTURER

Digitronics Corporation

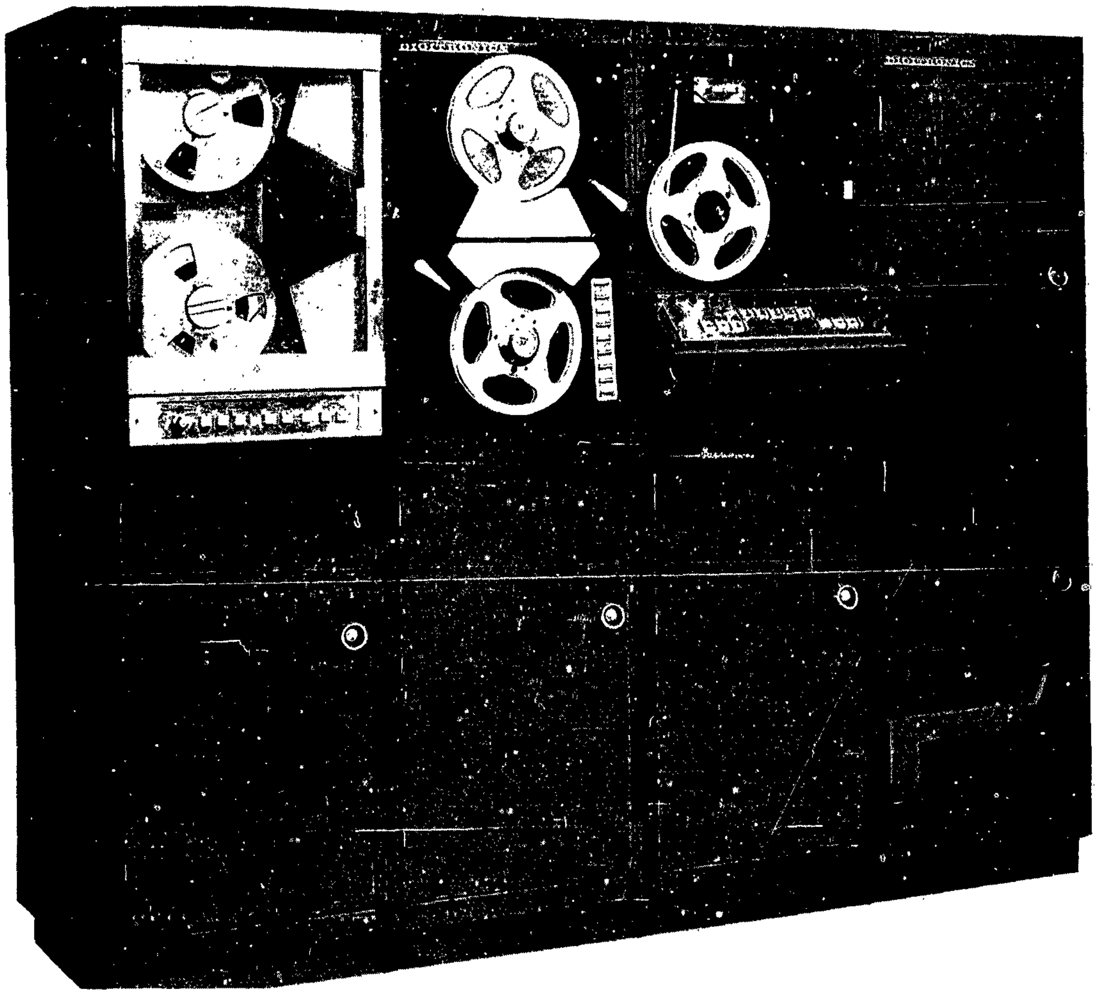


Photo by Digitronics Corporation

APPLICATIONS

System is designed for data conversion from magnetic tape to paper tape or vice versa, or from one magnetic tape to another, with numerous editing and format control operations. There is data-controlled selection of alternative outputs and a provision is made for grouping several input messages into one output message or vice versa.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Timing	Asynchronous
Operation	Sequential

System is plugboard programmed. Code translation is possible from any 6-bit to any other 6-bit code. Selective translation is based on character position in a message or on the column splits. Automatic zero suppression and insertion of editing characters may be performed as required. There is data-con-

STORAGE

Media	No. of Char	Access Microsec
Core Matrix	Up to 1,024	20

Magnetic Tape

No. of units that can be connected	2 Units
No. of chars/linear inch of tape	200 Chars/inch
Channels or tracks on the tape	8 Tracks/tape
Tape speed	75 Inches/sec
Transfer rate	15,000 Chars/sec
Start time	5 Millisec

Stop time	5 Millisec

Tape units normally furnished have above characteristics and handle IBM or Univac compatible tape. Optional provision for control of Uniservo or IBM high density tape units.

INPUT

Media	Speed
Magnetic Tape	15,000 char/sec
Compatible with IBM, Univac, or other specified system	
Punched Paper Tape	1,000 char/sec
Reel/strip or strip only	

OUTPUT

Media	Speed
Magnetic Tape	15,000 char/sec
Compatible with IBM, Univac, or other specified system	
Punched Paper Tape	100 char/sec
Using Teletype punch	
Punched Paper Tape	240-300 char/sec
Using Soroban punch	

Two or more output units can be provided with selection controlled by first character of message through plugboard.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Use
Diodes	
General Transistor DX2, DX3	All logic circuits
Transistors	
GT1170 1228 1229	For amplification. These three types account for over 95% of all transistors used.

CHECKING FEATURES

Input magnetic tape parity check with automatic re-read, output memory parity check, and input paper tape parity check, if applicable, are among the checking features. An output magnetic tape read-after-write check is optional.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

A 30 amp, 115 volts, 60 cycle, power outlet is required.

PRODUCTION RECORD

Number produced to date	3
Number in current operation	3
Number on order	2
Time required for delivery	6 - 7 months

PERSONNEL REQUIREMENTS

One technician is required per 8-hour shift.

Training made available by the manufacturer to the user includes maintenance training.

ADDITIONAL FEATURES AND REMARKS

There is a wide choice of editing features, all plugboard controlled. The system relieves a general purpose computer of the necessity for communication with any medium slower than magnetic tape, and handles large proportion of the input and output editing.

DISTRIBUTAPE

Distributing Tape Computer

MANUFACTURER

Litton Industries
Monroe Calculating Machine Division

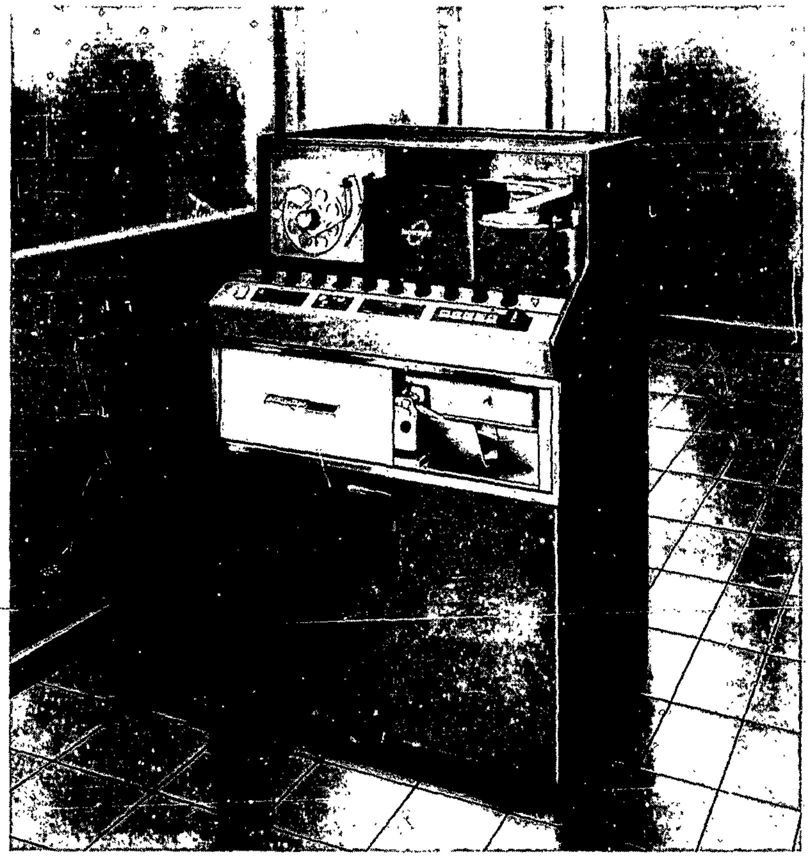


Photo by Monroe Calculating Machine Division

APPLICATIONS

Distributape was designed as a specicl purpose computer to sort and summarize at high speed unit record information which as been recorded in the medium of punched paper tape. This computer finds application in those areas where source data can be recorded on punch tape--such data being recorded in random sequence and whose subsequent processing requires sorting and summarizing for use in statistical or financial reports.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Arithmetic system	Fixed point
Number range	0 to $\pm 10^{11}$

Programming is controlled partially by instructions contained in input tapes and partially by control switch selection.

ARITHMETIC UNIT

Construction (Arithmetic unit only)

Vacuum-Tubes	Type 5965	130
Diodes	Type 1N636	1,700
Arithmetic mode	Serial	
Timing	Synchronous	
Operation	Sequential	

STORAGE

Medium	No. of Words	Access Microsec
Magnetic Drum	1,000	8,000

Access time is average.

INPUT

Medium	Speed
Paper Tape	235 char/sec

OUTPUT

Medium	Speed
Paper Tape	17 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
Primarily 5965	150
Diodes	
Primarily 1N636	1,964
Transistors	64

CHECKING FEATURES

Checking features include a paper tape parity check, a proof total balance check, and an instruction code sequence check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	2 Kw
Volume, computer	45 cu ft
Area, computer	9 sq ft
Room size	300 sq ft
Floor loading	50 lbs/sq ft
Weight, computer	450 lbs

Utilities required is one 30 amp service outlet, 115 volts, AC, 60 cycles.

PRODUCTION RECORD

Number produced to date	3
Number in current operation	2
Time required for delivery	6 months

COST, PRICE AND RENTAL RATES

The Distributape Computer and the Model 135 Printer are available at a total cost of $45,000 or a monthly rental of approximately $1,250.

Service contracts are available for customer owned machines at $2,000/year. Rental contract prices include service.

PERSONNEL REQUIREMENTS

System requires 1 operator for each 8-hour shift. Training is made available by the manufacturer to the user.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Operating experience with two machines currently in use indicates that usable computer time as a percentage of operating time can be maintained at 95 per cent or higher.

ADDITIONAL FEATURES AND REMARKS

Address selection and sort control feature permits a rapid flexible means of sorting data in many different ways without use of plugboards.

This system provides a means for sorting and summarizing data which has been recorded in random sequence in the medium of punched paper tape.

DYSEAC

Second Standards Electronic Automatic Computer

MANUFACTURER

Electronic Computer Laboratory
Data Processing Systems Division
National Bureau of Standards
U. S. Department of Commerce

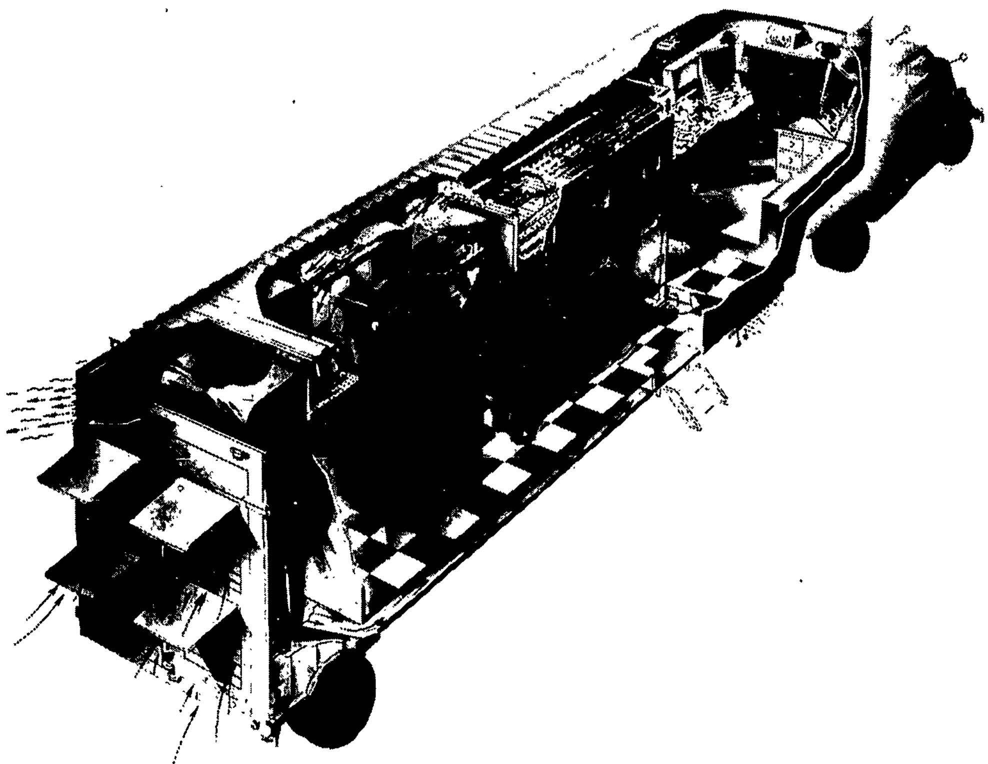


Photo by the National Bureau of Standards

APPLICATIONS

General purpose, simulation, real-time control.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	45 plus check digit
Binary digits/instruction	45 plus check digit
Instructions per word	1
Instructions decoded	16
Instructions used	16
Arithmetic system	Fixed point
Instruction type	Three address
Number range	$-(4 - 2^{-42}) \leq n \leq (4 - 2^{-42})$

ARITHMETIC UNIT

Time	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	192 - 1,536	48
Mult	2,304 - 3,648	2,112
Div	2,304 - 3,648	2,112

Construction Diode gates, tube amplifiers, and electrical delay lines

Rapid access word registers 3

Basic pulse repetition rate One megacycle/sec.

A four phase clock is used.

Arithmetic mode Serial

Timing Synchronous

Operation Storage and arithmetic processing are serial. Input-output external control are concurrent with arithmetic operations. In addition to the normal complement of operations, the operations of summation, accumulation, overflow check justification, shift, and file are also included.

STORAGE

Media	Words	Digits	Access Microsec
Mercury Delay Line	512	24,576	48-384

There is provision for up to 4,096 words of high speed storage. In addition, the computer has provisions for the attachment of many multi-channel magnetic tape or wire units, and a magnetic drum. These would operate concurrently with computation operations.

INPUT

Media	Speed
Keyboard	Manual
Paper Tape Reader	10 char/sec
Magnetic Wire	3,500 dig/sec

Keyboard and punched paper tape reader is a Flexowriter. Alpha-numeric operation is utilized. There is provision for the attachment of a wide variety of input devices that would operate concurrently with computation. There is also a one-word addressable switch memory via a serializer unit.

OUTPUT

Media	Speed
Typewriter (Flexowriter)	10 alphanum char/sec
Paper Tape Punch	60 char/sec
CRT Display Unit	2,000 words/sec
Magnetic Wire	3,500 dig/sec

There is provision for the attachment of a wide variety of output devices that would operate concurrently with computation.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	900
Tube types	90% are 1 type
Crystal diodes	24,500
Separate cabinets	2

There are 524 tubes in the central computer and 350 in the storage unit. The central computer utilizes 21,500 crystal diodes. The central computer has two basic types of package. One type contains tube amplifiers and diode gates. The other type contains delay lines and diode gates. There are 524 tube packages and 251 delay-line packages.

CHECKING FEATURES

Fixed

Odd - even parity check on storage.

Optional

Automatic program jump or print-outs are optional upon detection of a memory error. Also available for program checking are a wide variety of automonitoring operations for loading and printing out of internal storage locations and substituting new instructional addresses. Each word is checked as it is read from the memory. A real-time clock periodically initiates a storage scan which checks the entire storage.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	12 Kw	20 KVA
Power, air cond.		35 KVA
Volume, computer		270 cu ft
Volume, air conditioner		750 cu ft
Capacity, air conditioner		18 Tons

There are two trailer vans. Van No. 1 contains the control console, input-output, computer, storage, and 12 tons of refrigeration capacity. Its internal dimensions are approximately 39 x 7 x 9 feet and weighs about 12 tons. Van No. 2 contains DC power supplies, 6 tons of refrigeration capacity, and 1,700 cubic feet of spare space. This van also has internal dimensions of 39 x 7 x 9 feet. It weighs 8 tons.

PRODUCTION RECORD

Number produced	1
Number operating	1

The DYSEAC was designed and constructed by the Electronic Computer Laboratory of the National Bureau of Standards as part of a development program under the sponsorship of the Department of Defense. It was delivered to the Signal Corps in May 1954.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Acceptance test passed in April 1954.

ADDITIONAL FEATURES AND REMARKS

For further information on this system see

Transactions of the IRE-PGEC, Vol. EC-3, No. 1, Mar. 1954.

Transactions of the IRE-PGEC, Vol. EC-3, No. 2, June 1954.

Journal of the ACM, Vol. 1, No. 2, pp 57-81, April 1954.

Proceedings of the IRE, Vol. 41, Oct. 1953, pp 1380-1387.

Circular No. 551 National Bureau of Standards, January 1955.

Two counter-registers are provided for program sequencing. Each counter holds a twelve-binary-digit address. The coder may select the address in either counter as the address of the next instruction to be performed. Also, either counter-register can furnish the base number for relative addresses.

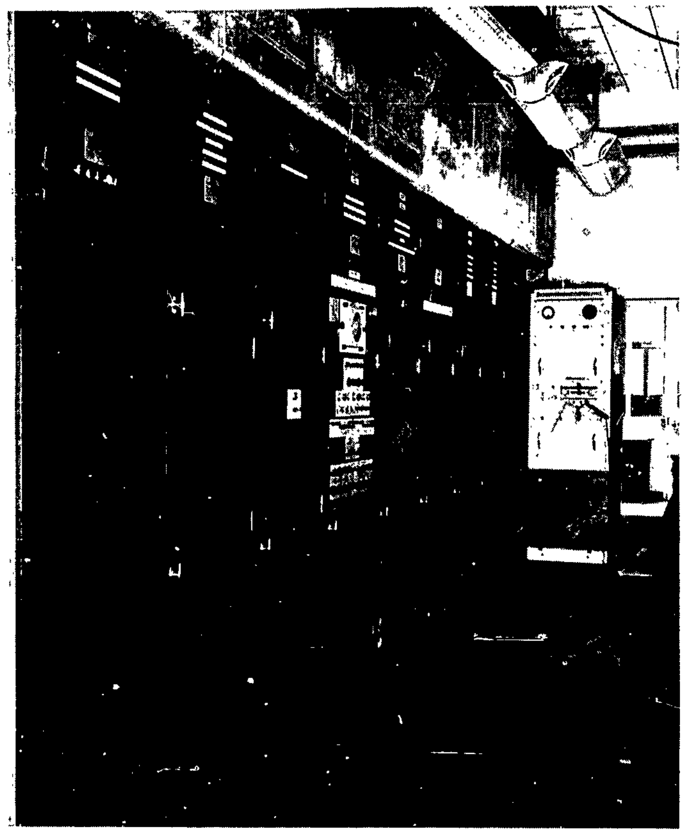
Major design emphasis was placed on versatility of control facilities and on latitude for expansion of the installation. The versatility is achieved by (1) the concurrent input-output property, (2) a self-regulation property which allows the external environment to automatically control the pace of the internal work program, (3) an interruption property which enables the machine to handle unscheduled job assignments which originate externally without advance notice and must be executed as soon as possible, and (4) the preceding three properties acting in concert enable the machine to be employed as a control element in a generalized feedback loop.

EDVAC

Electronic Discrete Variable Automatic Computer

MANUFACTURER

Moore School of Electrical Engineering
University of Pennsylvania



U. S. Army Photo

APPLICATIONS

Ballistic Research Laboratories

Exterior ballistics problems such as high altitude, solar and lunar trajectories, computation for the preparation of firing tables and guidance control data for Ordnance weapons, including free flight and guided missiles.

Interior ballistic problems, including projectile, propellant and launcher behavior, e.g. physical characteristics of solid propellants, equilibrium composition and thermodynamic properties of rocket propellants, computation of detonation waves for reflected shock waves, vibration of gun barrels and the flow of fluids in porous media.

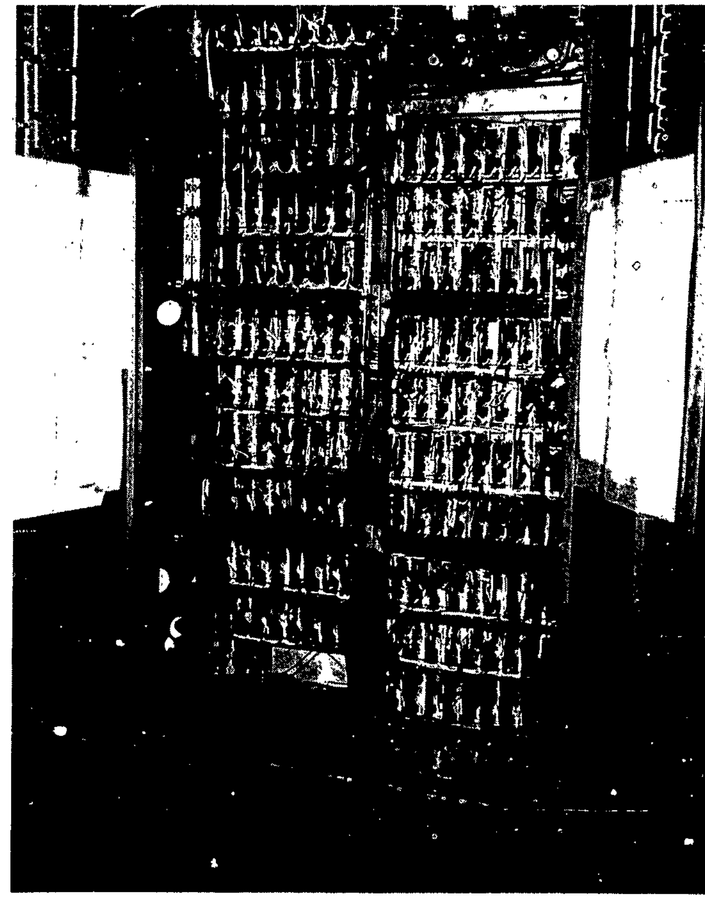
Terminal ballistic problems, including nuclear, fragmentation and penetration effects in such areas as explosion kinetics, shaped charge behavior, ignition, and heat transfer.

Ballistic measurement problems, including photogrammetric, ionospheric, and damping of satellite spin calculations, reduction of satellite doppler tracking data, and computation of satellite orbital elements.

Weapon systems evaluation problems, including anti-aircraft and anti-missile evaluation, war game problems, linear programming for solution of Army logistical problems, probabilities of mine detonations, and lethal area and kill probabilities of mine detonations, and lethal area and kill probability studies of missiles.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	44
Binary digits per instruction	4 bits/command
10 bits each address	
Instructions per word	1
Instructions decoded	16
Instructions used	12
Arithmetic system	Floating and Fixed point
Instruction type	Four-address code



EDVAC Floating Point

U. S. Army Photo

Number range

Fixed $-(1-2^{-43}) \leqslant n \leqslant (1-2^{-43})$

Floating $-(1-2^{-33})2^{511} \leqslant n \leqslant (1-2^{-33})2^{511}$

The fractional part of floating point number has 33 bits plus sign, and the exponent of 2 may range from -512 to +511.

Instruction word format

α-Add	β-Add	γ-Add	δ-Add	Order
1 - 10	11 - 20	21 - 30	31 - 40	41 - 44

ARITHMETIC UNIT

	Microsec
Add time (includ. stor. access) (min 192 max 1,536)	864
Mult time (includ. stor. access) (min 2,208 max 3,552)	2,880
Div time (includ. stor. access) (min 2,256 max 3,600)	2,930

Construction	Vacuum-tubes and Diode-gates
Number of rapid access word registers	4
Basic pulse repetition rate	1.0 megacycle/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	Number of Words	Number of Digits	Access Microsec
Mercury A.D.L.	1,024	48-384	48-384
Magnetic Drum	4,608	48/Word	17,000

Includes relay hunting and closure.

The rate of information transfer to and from the drum is at one megacycle per second. The block length is optional from 1 to 384 words per transfer instruction.

Magnetic Tape 48/Word

Maximum number of units that can be connected to the system	7 Units
Maximum number of characters per linear inch of tape	112 Char/inch
Channels or tracks on the tape	8 Track/tape
Blank tape separating each record	1.5 Inches

Tape speed	75 Inches/sec
Start time	3 Milliseconds
Stop time	3 Milliseconds
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	5/8 Inches
Length of reel	1250/2500 Feet
Composition	Red Oxide

The magnetic tape system has the following features:

Variable block length from 2 to 1,024 words.

The search order releases the machine for computation during search.

Information which has been taken from a block and operated upon, can be automatically re-recorded in the same block.

INPUT

Media	Speed
Photoelectric Tape Reader	942 sexadec char/sec
	78 words/sec
Card Reader (IBM)	146 cards/min
	8 words/card

OUTPUT

Media	Speed
Paper Tape Perf.	6 sexadec char/sec
	30 words/min
Teletypewriter	6 sexadec char/sec
	30 words/min
Card Punch	125 cards/min
	1,000 words/min

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity		Type	Quantity
Tubes, total		5,937		
6Y6	1,000		6AN5	275
6J6	1,500		2D21	160
6AG7	1,127		6SN7	150
6V6	900		6AS6	50
6L6	275		Misc	500
Diodes, total		12,000		
1N297	6,000		Misc	1,200
1N 34	4,800			
Transistors, total		328		
2N398	256		2N123	4
2N1008B	60		2N167	4
2N 43	4			

CHECKING FEATURES

Two arithmetic units perform computation simultaneously, discrepancies halt machine.
Unused commands halt machine.
Paper tape reader error detection.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	52 K.W.
Space, computer	490 sq. ft. floor
Weight, computer	17,300 lbs.
Power, air cond.	25 K.W.
Space, air cond.	6 sq. ft. floor
Weight, air cond.	4,345 lbs.
Capacity, air cond.	20 Tons

PRODUCTION RECORD

Number produced	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Approximate cost, basic system $467,000

Rental rates for additional equipment

I.B.M.	card reader	$82.50 per month
I.B.M.	card punch	$93.50 per month

PERSONNEL REQUIREMENTS

Typical Personnel

	Three 8-Hour Shifts
Supervisors	6
Analysts	3
Programmers and Coders	14
Clerks	1
Engineers	1
Technicians	6

No engineers are assigned to the operation of the machine, but are used for development and design of additions to the machine. The technicians consult the engineers when a total break-down occurs.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running time	Approx. 8 hours
Good time	145 hours/week
Attempted to run time	168 hours/week
Operating ratio	0.87

Figures based on last 3 years.
The 23 hours per week are devoted to scheduled and unscheduled maintenance, testing, modifications and improvements, time lost due to error, etc. The 145 hours are good, useful production time.
EDVAC has been operating since 1949.

ADDITIONAL FEATURES AND REMARKS

Oscilloscope and neon indicator for viewing contents of any storage locations at any time.

Exceed capacity options: halt, ignore, transfer control, or go to selected location.

Unused instruction (command) halt.

Storage of previously executed instruction and which storage location it came from, for viewing during code checking.

Storage of current instruction and storage location it originated from.

Address halt when prescribed address appears in any of 4 addresses of instruction to be executed by computer.

Tape reader error detection.

Built in automatic floating point equipment.

Magnetic tape auxiliary storage unit and high speed printing techniques are being investigated.

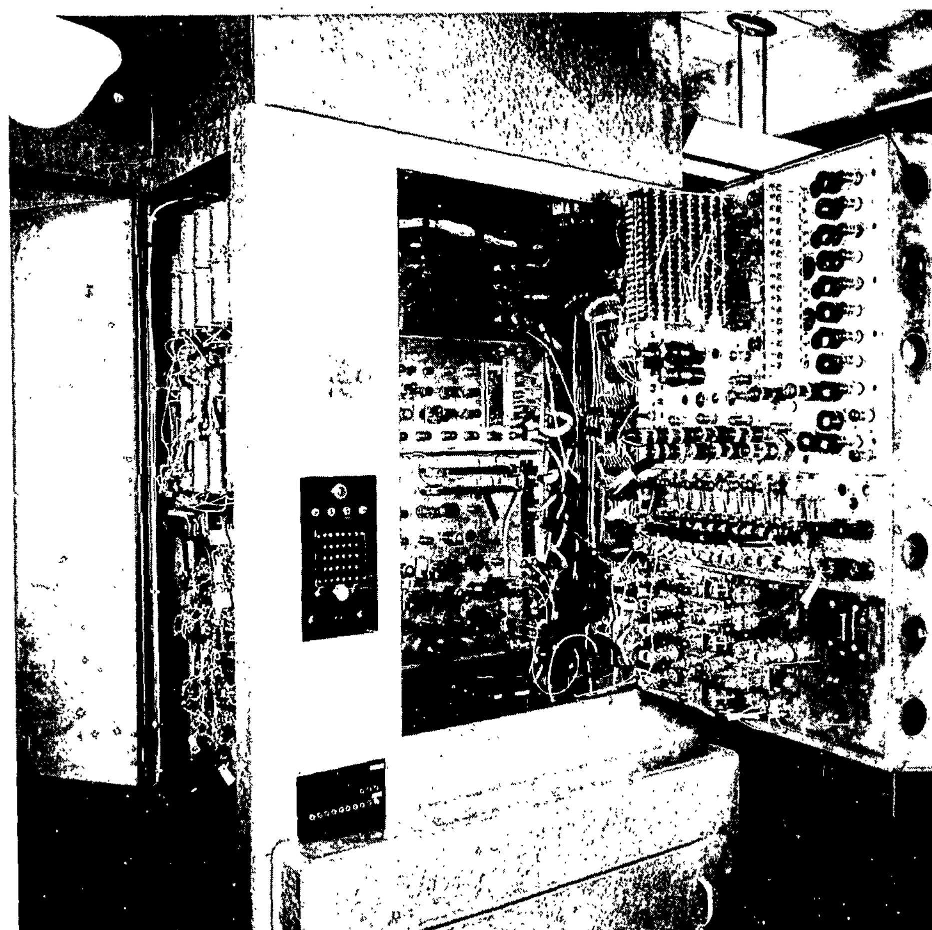
Punching one card requires from 384 to 768 microseconds. The computer may proceed between cards.

INSTALLATIONS

Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland

FUTURE PLANS

A second magnetic drum system, of 16,128 words capacity is being added to the EDVAC. The transistorized track selector will permit channel switching in 48 microseconds.



Synchronous Magnetic Drum U. S. Army Photo

ELECOM 50

Electronic Computer Type 50

MANUFACTURER

Underwood Corporation
Electronic Computer Division

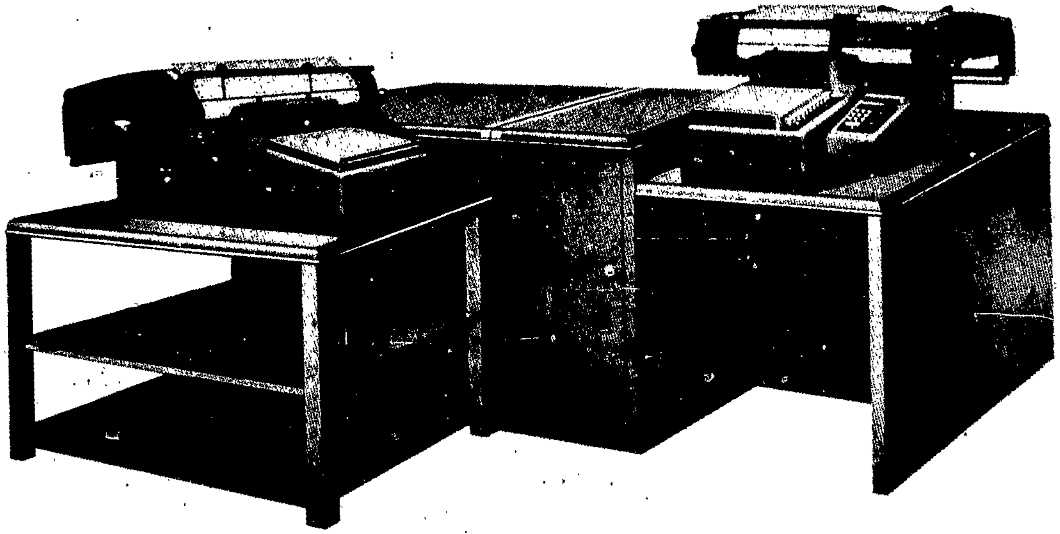


Photo by Underwood Corporation, Electronic Computer Division

APPLICATIONS

Commercial (Out of Production)

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Decimal
Decimal digits per word	10 plus sign
Instructions decoded	42 plus combinations
Arithmetic system	Fixed point
Number range	.000001 to 99999999

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add time	650
Mult time	39,000
Construction	Vacuum tubes
Rapid access word registers	3
Basic pulse repetition rate	67 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

One minor cycle is 650 microseconds. Multiplication requires 60 minor cycles.

STORAGE

Media	Words	Digits	Access Microsec
Magnetic Drum (Main)	100	1,000	33,000
Magnetic Drum (Working Registers)	3	30	325

INPUT

Media	Speed
Keyboard	Manual
Paper Tape	20 dec dig/sec

OUTPUT

Media	Speed
Printers (Two-gang)	10 char/sec
Paper Tape	2 dec dig/sec

The printers operate in parallel.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	160
Tube types	5
Crystal diodes	2,000
Number of different kinds of plug-in units	42
Number of separate cabinets, excluding power supplies and air conditioners	3

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	2 Kw
Volume, computer	50 cu ft
Area, computer	20 sq ft
Weight, computer	750 lbs

PRODUCTION RECORD

System is out of production. As of June 1957, the following figures were reported:

Produced	3
In production	50
Operating	3
On order	50

COST, PRICE AND RENTAL RATES

Approximate cost of basic system	$22,500
Rental rates of basic system	$ 600/month

(As of June 1957)

PERSONNEL REQUIREMENTS

Manufacturer

Daily Operation	Tech and Operators
One 8-hour shift	1
Two 8-hour shifts	2
Three 8-hour shifts	3

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Average error-free running period 6 Hours

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Simple operation
Programming by manufacturer
2,400 step program tape
Interchangeable program tapes

INSTALLATIONS

(As of June 1957)

Underwood Corporation
Electronic Computer Division
35-10 36th Avenue
Long Island City 6, New York (1)

Underwood Corporation
One Park Avenue
New York, New York (2)

American Telephone and Telegraph Company
195 Broadway
New York 7, New York

ELECOM 100

Electronic Computer Model 100

MANUFACTURER

Underwood Corporation
Electronic Computer Division

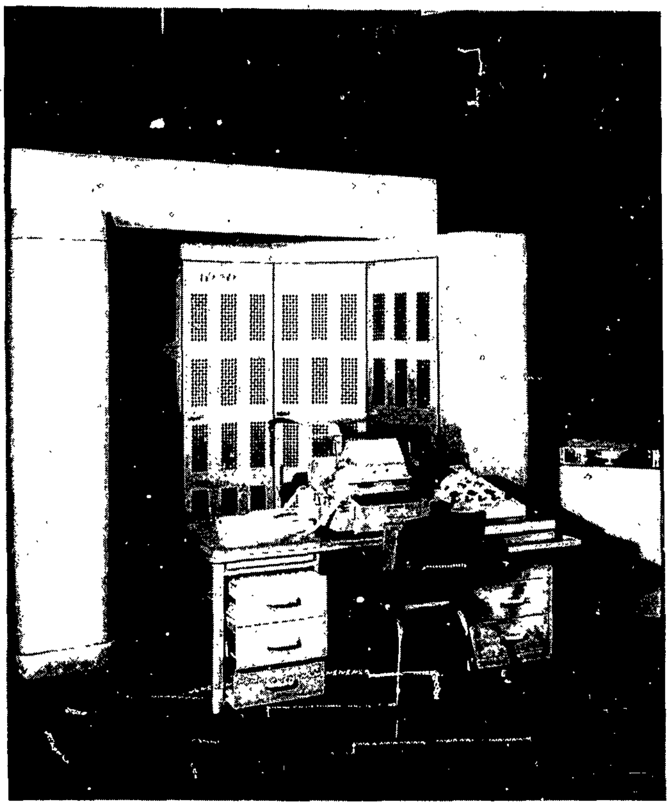


Photo by Underwood Corporation, Electronic Computer Division

APPLICATIONS

Manufacturer
Engineering and scientific. System not in production.

U.S. Army Aberdeen Proving Ground
Missiles, aircraft systems accuracy, expansion of firing tables, fire control problems.

Reeves Instrument Company
The computer is owned by the U.S. Navy, Bureau of Aeronautics, and is operated by Reeves Instrument Company under Project Cyclone.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	30
Binary digits/instruction	30
Instructions per word	1
Instructions decoded	8
Instructions used	8
Arithmetic system	Fixed point
Instruction type	Three address
Number range	$-(4-2^{-27})$ to $(4-2^{-27})$

The 8 instructions include an "external operation" which, in turn, includes six different operations. Octal number system is used.

ARITHMETIC UNIT

Construction	Vacuum tubes
Basic pulse repetition rate	100 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous (Magnetic Drum)
	Asynchronous (Magnetic Tape)
Operation	Sequential

25-50 operations per second may be performed, including drum storage access.

STORAGE

Media	Words	Access Microsec
Magnetic Drum	512	20,000
Magnetic Tape	60,000	

Access time is the maximum value. One block of tape is equivalent to one channel on the drum (64 words). A transfer, or movement of one block takes approximately 2 seconds.

INPUT OUTPUT

Media	Speed
Typewriter (Flexowriter)	Manual
Paper Tape (Flexowriter)	7.5 octal dig/sec
Typewriter	7.5 char dig/sec

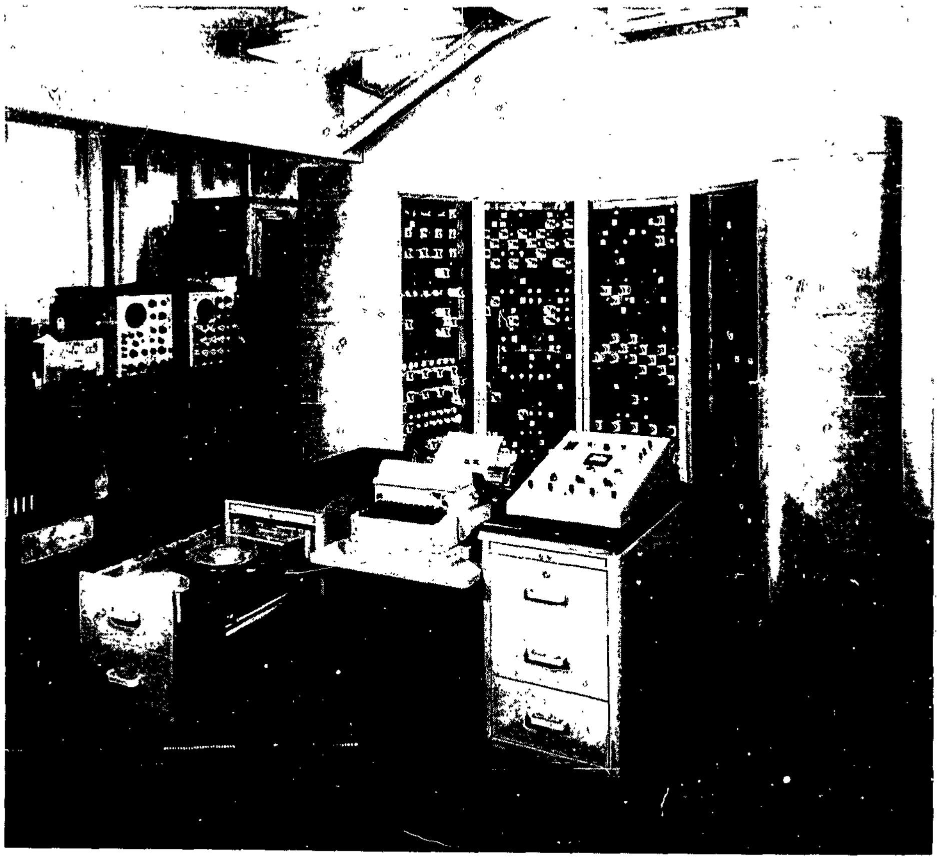


Photo by U. S. Army Development and Proof Services

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	230
Tube types	6
Crystal diodes	2,200
Separate cabinets	2
Number of different kinds of plug-in units	5

CHECKING FEATURES

Overflow indication and halt
Out of synchronous for tape and halt
Engineering diagnostic tests

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	3.5 Kw
Area, computer	120 sq ft

PRODUCTION RECORD

(June 1957 figures)

Number produced	3
Number operating	3

System out of production

COST, PRICE AND RENTAL RATES

(June 1957 figures)
Approximate cost of basic system $60,000.
System is no longer in production.

PERSONNEL REQUIREMENTS

One engineer and one technician required per 8 hour shift.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

First unit passed acceptance test on 9 December 1952.
U. S. Army, Aberdeen Proving Ground, D & PS

Good time	1,471 Hours
Attempted to run time	2,225 Hours
Operating ratio (Good/Attempted to run time)	0.66

FUTURE PLANS

System is no longer being manufactured.

INSTALLATIONS

Development and Proof Services
Aberdeen Proving Ground, Maryland

Reeves Instrument Corporation
215 E. 91st Street
New York 28, New York

ELECOM 120

Electronic Computer Model 120

MANUFACTURER

Underwood Corporation
Electronic Computer Division

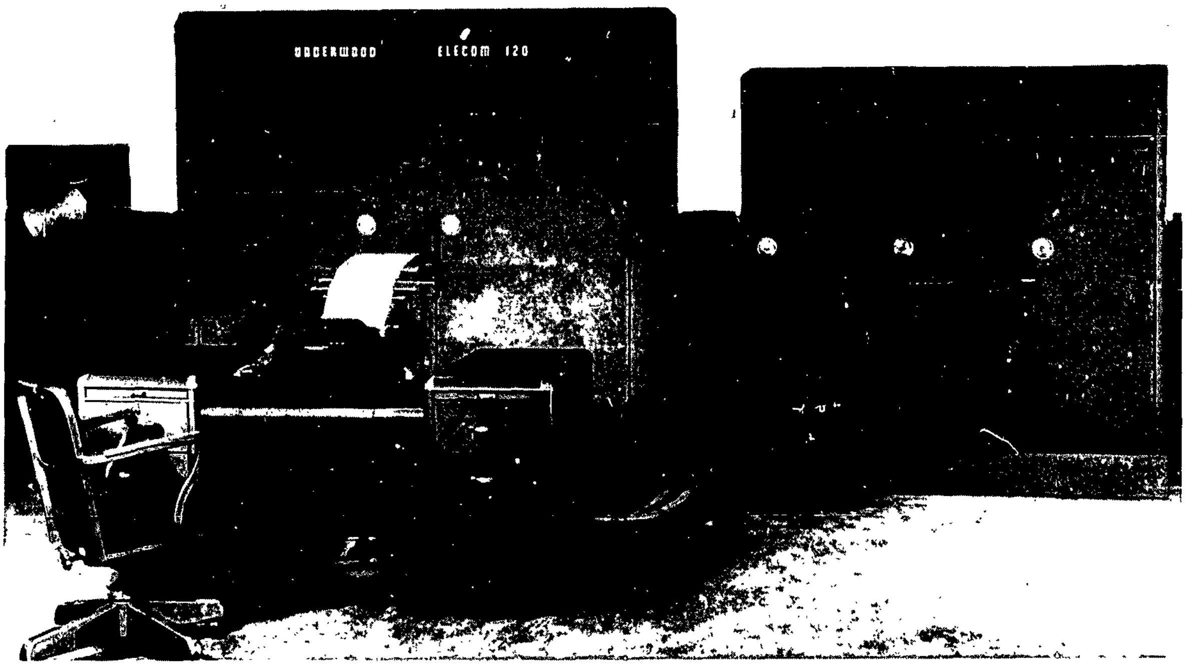


Photo by Underwood Corporation, Electronic Computer Division

APPLICATIONS

Manufacturer

Engineering and scientific applications. (Out of production).

Westinghouse Electric Corporation

Located at the Kansas City, Missouri, Engineering Department, the system is used for all types scientific computing, e.g. mechanical design, and stress calculations, and for semi-automatic data reduction.

Shell Development Company

Located at 3737 Bellaire Blvd., Houston, Texas, the system is used for scientific calculations arising in research and for data processing.

RADC Griffiss Air Force Base

Located in Bldg. 102, RADC, Griffiss AFB, N. Y., the system is used for scientific and engineering applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Decimal
Decimal digits/word	8 plus sign
Decimal digits/instruction	10
Instructions per word	1
Instructions decoded	33
Instructions used	33
Arithmetic system	Fixed and floating point
Instruction type	Two address

Number range

Fixed point $-(10-10^{-10}) \leq n \leq (1-10^{-10})$

Floating point Exponent $-50 \leq c \leq 49$

Coefficient $-(1-10^{-8}) \leq c \leq (1-10^{-8})$

Floating point operation is optional and is supplied with fixed point at extra cost.

ARITHMETIC UNIT

Manufacturer

	Exclud Stor Access Microsec
Add time	330
Mult time	18,300
Div time	18,700

Construction	Vacuum tubes and crystal diodes
Rapid access word registers	3
Basic pulse repetition rate	105 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Above operation times are for average 10 digit multiplier, dividend and divisor, respectively.

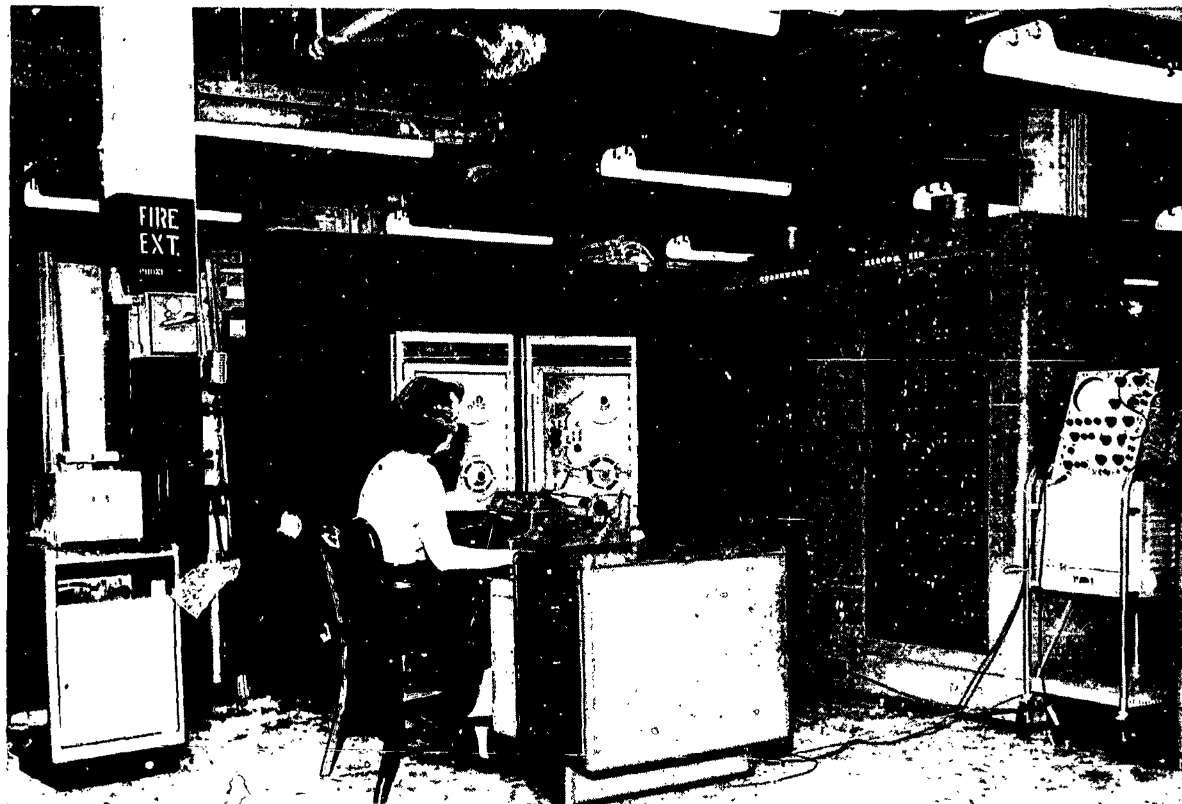


Photo by Griffiss Air Force Base, RADC

STORAGE

Manufacturer

Media	Words	Access Microsec
Magnetic Drum	1,000-10,000	8,300 avg.
Magnetic Drum	10-100	1,670 avg.

Main storage is on single head per channel basis. Fast access storage is a group of recirculating channels.

Griffiss AFB

Media	Words	Digits	Access Microsec
Magnetic Drum	1,000	8 plus sign	20,000 max. 330 min.
Magnetic Tape (2) (Potter Mod 902)	125,000	8 plus sign	1,600

Shell

Magnetic Drum	1,000	8 plus sign	20,000 max
Magnetic Tape	100,000	8 plus sign	10^6/50 words

Westinghouse

Drum	1,010	8	330

INPUT

Manufacturer

Media	Speed
Typewriter	Manual and 8 char/sec
Paper Tape reader	8 to 400 char/sec
Magnetic Tape	400 char/sec

The typewriter is standard equipment. The high-speed paper tape reader is optional. One magnetic tape unit is supplied as standard equipment. Standard model includes controls for additional tape units.

Griffiss AFB

Paper Tape (Flexowriter)	8 char/sec
Paper Tape (Ferranti)	200 char/sec
Keyboard (Flexowriter)	Manual

Shell

Paper Tape (Flexowriter)	1 word/sec
Paper Tape (Ferranti)	20 words/sec
Keyboard (Flexowriter)	Manual

For program check-out and manual modification of program on data. Paper tape reading system does not operate satisfactorily. There is no error detection in reading.

Westinghouse

Paper Tape	200 char/sec
Paper Tape (Flexowriter)	8 char/sec

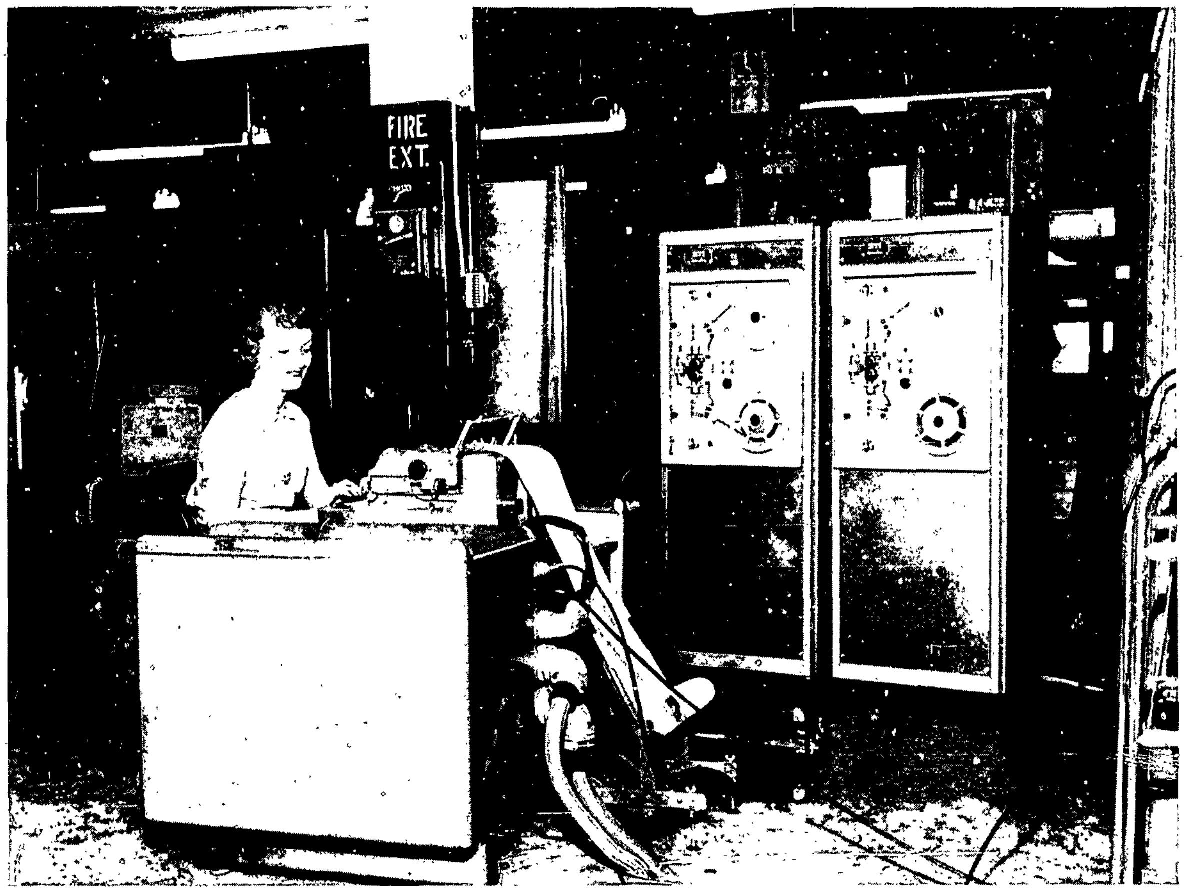


Photo by Griffiss Air Force Base, RADC

OUTPUT

Manufacturer

Media	Speed
Typewriter	8 char/sec
Paper Tape	8 or 60 char/sec
Magnetic Tape	400 char/sec

Typewriter is standard equipment. High speed paper tape punch is optional.

Griffiss AFB

Typewriter (Flexowriter)	8 char/sec

Shell

Typewriter (Flexowriter)	1 word/sec
Paper Tape (Flexowriter)	1 word/sec
Paper Tape (Yawman)	6 words/sec

Westinghouse

Paper Tape	60 char/sec
Paper Tape (Flexowriter)	8 char/sec
Typewriter (Flexowriter)	8 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	400
Crystal diodes	4,500

95% of tubes are of two basic types. This system utilizes the 12AT7, 6CL6, 5687, and 2C51 in the arithmetic unit. Diodes used are 1N34A, 1N140 and 1N91.

CHECKING FEATURES

Internal check for forbidden pulse combinations and check of drum-writing operations. Parity check on tapes with automatic re-read.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	5 to 7 Kw
Volume, computer	200 cu ft
Weight, computer	3,500 lbs

These figures are for computer complete with control desk and one tape unit.

Griffiss AFB

Power, computer	7 Kw	7.5 KVA	0.9 pf
Volume, computer		200 cu ft	
Area, computer		50 sq ft	
Room size		400 sq ft	
Weight, computer		4,500 lbs	

Computer sets on locally fabricated false floor. Air conditioner is shared with many other equipments.

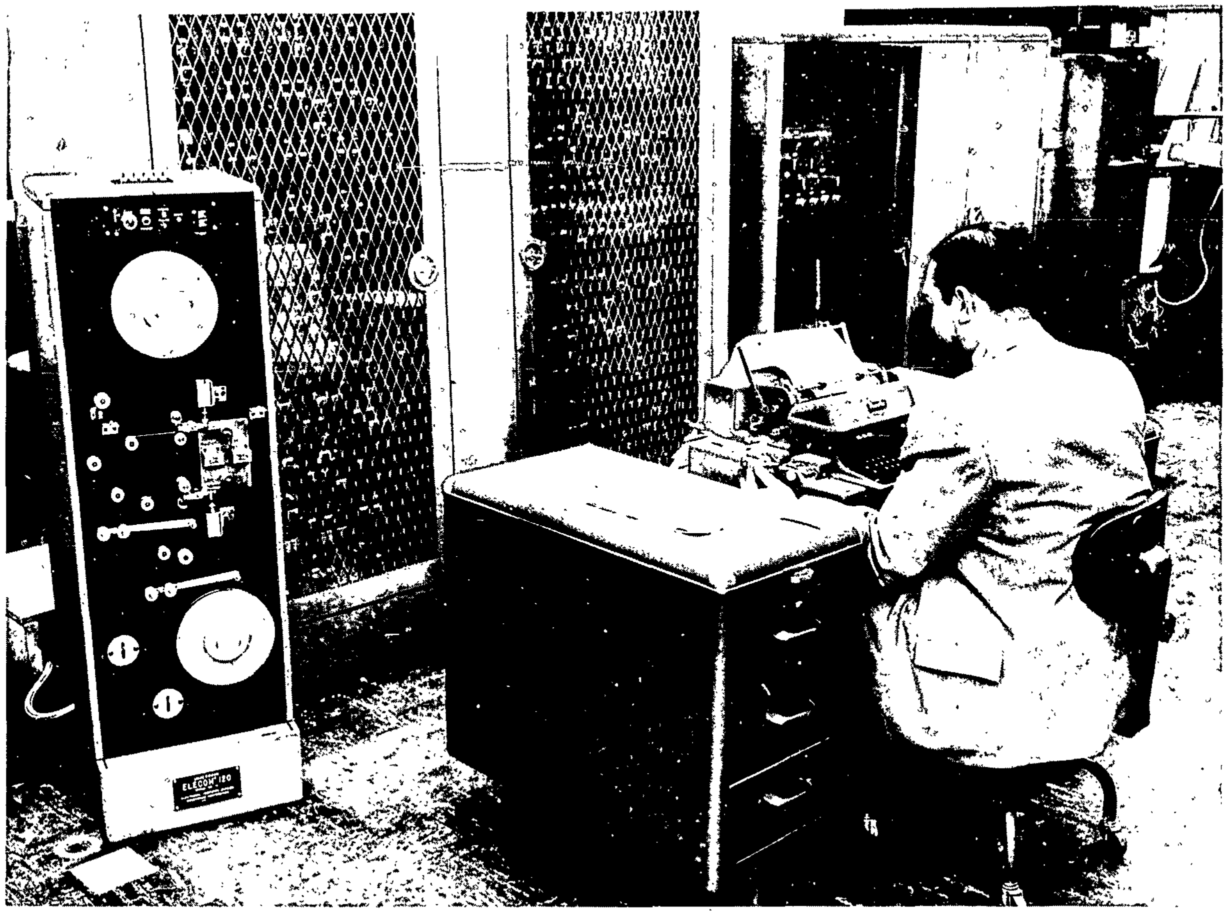


Photo by Republic Aviation Corporation

Shell

Power, computer	7 Kw	7.5 KVA	0.9 pf
Volume, computer		200 cu ft	
Area, computer		93 sq ft	
Room size		10 ft x 20 ft	
Floor loading		35 lbs/sq ft	
Weight, computer		3,500 lbs	

Sound-proof material on walls. Exhaust system. Two tons additional air-conditioning in air-conditioned room.

Westinghouse

Power, computer	5 Kw	5 KVA	
Power, air cond		4.4 KVA	0.8 pf
Volume, computer		250 cu ft	
Volume, air conditioner		42 cu ft	
Area, computer		95 sq ft	
Area, air conditioner		6.5 sq ft	
Room size, computer		20 ft x 20 ft	
Room size, air conditioner		5 ft x 4 ft min	
Floor loading		40 lbs/sq ft	
		800 lbs concen max	
Capacity, air conditioner		5 Tons	
Weight, computer		4,000 lbs	
Weight, air conditioner		940 lbs	

Power distribution transformer. 5 ton air conditioner.

PRODUCTION RECORD

(June 1957)

Number produced	5
Number in operation	5

System is no longer in production.

COST, PRICE AND RENTAL RATES

Manufacturer
(June 1957)

Approximate cost of basic system $97,000. Rental rates of basic system $3,500/month for complete system, including maintenance.

System is out of production.

Griffiss AFB

System purchased at $90,000 plus $35,000 for additional equipment.

Shell

Purchased at $90,000, for central processor, control desk, Ferranti reader, Yawman punch, and Potter tape device.

Westinghouse

Basic system purchased at $90,000.

Additional equipment

High Speed Punch	$ 3,600
Photo Electric Reader	5,000
(2) Flexowriters	5,200
Test Equipment	2,000

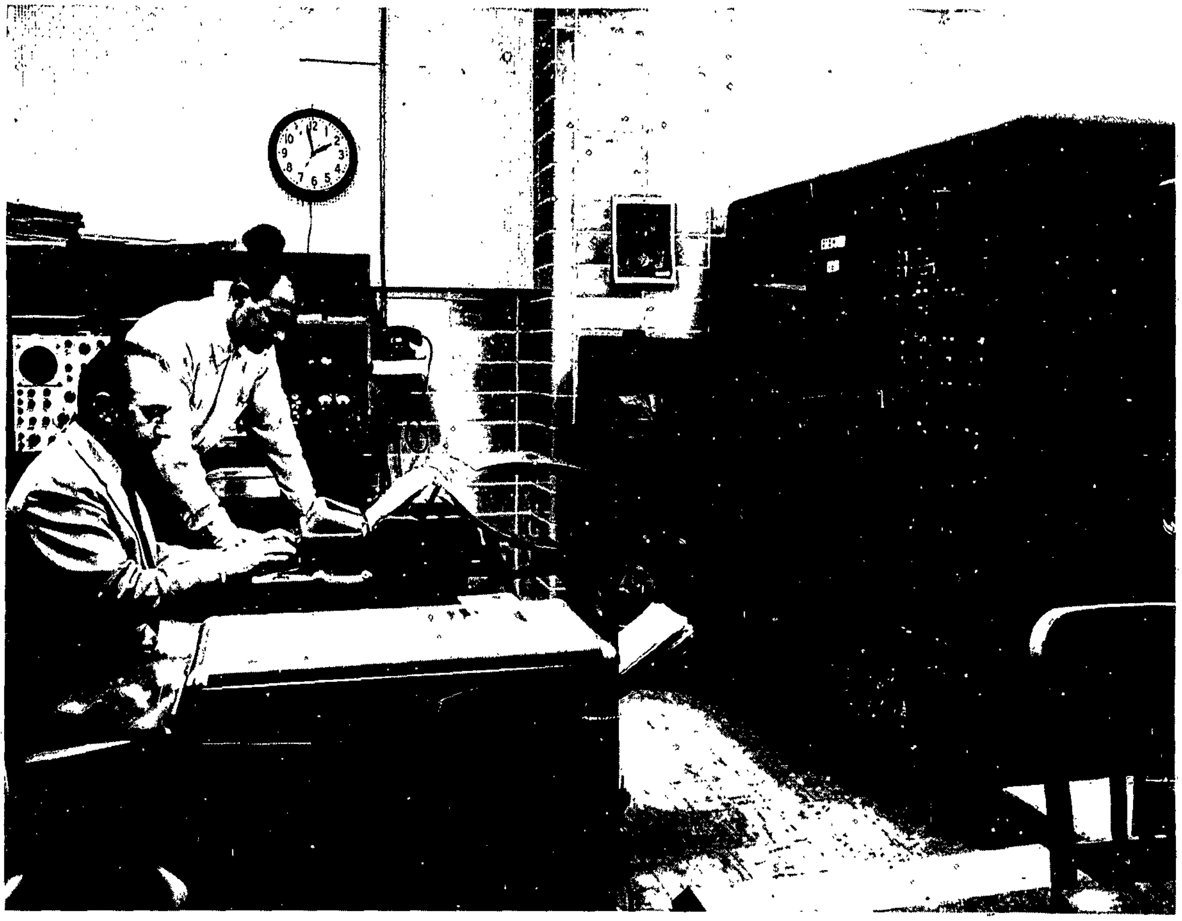


Photo by Shell Development Company, Exploration and Production Research Division

Card to tape converter rents at $85.
Maintenance performed by local computer group.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Engineers	1	2	3
Tech and Operators	1	2	3

Griffiss AFB

	One 8-Hour Shift Used	One 8-Hour Shift Recommended
Engineers	1	1

Operation tends toward closed shop.
Methods of training used include instruction manuals and on-the-job training.

Shell

Five persons are utilized with the system, covering two 8-hour shifts and performing the functions of supervision, analysis, programming, coding, operating, and engineering.

Westinghouse

	One 8-Hour Shift Used	One 8-Hour Shift Recommended
Supervisors	1	1
Analysts	0	1
Programmers	3	3
Coders	3	4
Clerks	0	2
Operators	1	1
Engineers	1	1

Operation tends toward open shop.
Methods of training include on-the-job training, formal classes, assign new personnel to work with experienced. All system information for Elecom 120 only. Magnetic tape use has been discontinued.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Operating ratio (Good/Attempted to run) 0.90 to 0.95
Figure based on eight month period.
Above up-times (machine time available for problem work divided by total time) reported for 5 Elecom 120 Computer installations. At one location, up-times of 100% and 99.9% were obtained for two successive months.

Photo by Westinghouse Electric Corporation, Aviation Gas Turbine Division

Shell

Average error-free running period 5 Hours
Good time 80 Hours/Week (Average)
Attempted to run time 100 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.80
Above figures based on period from Jun 59 to May 60
Passed Customer Acceptance Test Jun 54
Time is not available for rent to outside organizations.

Westinghouse

Good time 60 Hours/Week (Average)
Attempted to run time 62 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period from May 54 to Apr 60
Passed Customer Acceptance Test May 54
Time is not available for rent to outside organizations.

Above time is average for a 6 year period. Drastic changes in scheduled work load have occurred during this time.

ADDITIONAL FEATURES AND REMARKS

Westinghouse

An outstanding feature is the high speed input-output, compared to internal speed mixture of numeric and alphebetic information. System is very good with automatic data taking and plotting equipment.

Little is given to magnetic tape protection except air conditioning for temperature.

Little preventive maintenance done. Circuit modifications have been made that increase reliability. 6677 tubes to replace 6CL6 have improved system.

FUTURE PLANS

Shell

Retirement is planned during last quarter of 1960.

INSTALLATIONS

Rome Air Development Center
Griffiss Air Force Base, New York

Shell Development Company
3737 Bellaire Blvd.
Houston, Texas

Westinghouse Electric Company, Box 288
Kansas City, Missouri

ELECOM 125 125 FP

Elecom Type 125 Computer and Elecom Type 125 File Processor

MANUFACTURER

Underwood Corporation
Electronic Computer Division

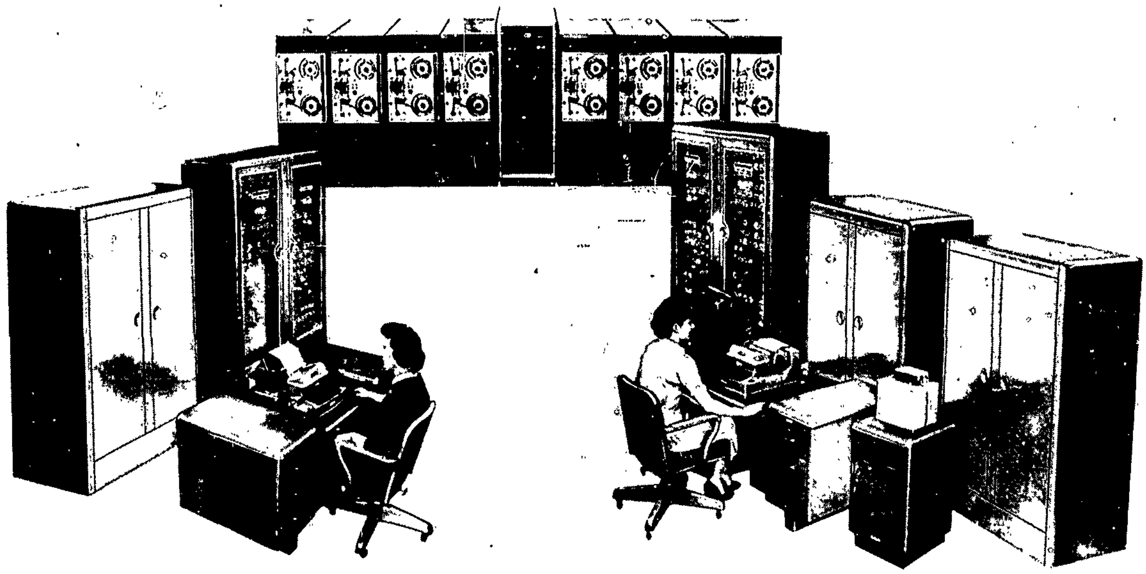


Photo by Underwood Corporation, Electronic Computer Division

APPLICATIONS

Manufacturer

Commercial, engineering and scientific. The Elecom 125FP is primarily commercial. The system is no longer in production.

Sandia Corporation

Located in Building 880 at the Sandia Corporation, Albuquerque, New Mexico, the Elecom 125 is used for scientific computation and engineering studies.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Decimal
Decimal digits/word	10 and sign
Decimal digits/instruction	10
Instructions/word	1
Instructions decoded	36
Instructions used	36
Arithmetic system	Floating and fixed
Instruction type	Two address
Number range	
Coefficient range	$-(1-10^{-8}) \leq c \leq (1-10^{-8})$
Exponent range	$-50 \leq e \leq 49$
Fixed point range	$-(1-10^{-10}) \leq n \leq (1-10^{-10})$

Floating point is optional at extra cost and is additional to fixed point. Fixed point is standard. The Elecom 125FP utilizes 2 decimal dig/alpha char. It operates on "Items" containing any integral number of words. Fixed program, switch-selected; sequence, collate, select, collate and select, separate, and substitute. The following combinational operations are available as an option: Select-separate, collate-separate, substitute-separate, collate-select-separate.

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add time	330
Mult time	18,300
Div time	18,700
Construction	Vacuum tubes
Rapid access word registers	3
Basic pulse repetition rate	132 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Above operation time is based on average 10 decimal digit multiplier, dividend and divisor.

Sandia Corporation

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add time	3,500	330
Mult time	22,000	18,000
Div time	22,000	18,000

The above figures are obtained for 10 digit numbers.

STORAGE

Media	Words	Access Microsec
Magnetic Drum	4,000 to 10,000	8,300 avg.
Magnetic Drum	50 to 100	1,670 avg.

Main storage operates on a single head per channel basis. The rapid-access storage is a recirculation channel. The Elecom 125 FP has a 100 word acoustic delay line.

Sandia Corp.

Media	Words	Digits
Magnetic Drum	4,000	10 plus sign
Paper Tape		
Magnetic Tape		

INPUT

Media	Speed
Typewriter	8 char/sec and Manual
Paper Tape	8 to 400 char/sec
Magnetic Tape	6,000 char/sec
Cards (IBM 528 or similar)	

The typewriter is standard equipment. The high speed tape reader and punched card unit is optional. Magnetic tape synchronizing circuits and controls are included as standard equipment. The Elecom 125 FP unit is utilized in conjunction with magnetic tape and typewriter. The typewriter and punched paper tape are used for checking and control.

Sandia Corp.

Paper Tape	400 char/sec
Magnetic Tape	7,500 char/sec
Manual	

OUTPUT

Media	Speed
Typewriter	8 char/sec
Paper Tape	8 or 60 char/sec
Magnetic Tape	6,000 char/sec
Cards (IBM 523)	6,000 char/sec
Tabulation (IBM 407)	

Typewriter is standard equipment. High speed paper tape and card equipment are optional.

Sandia Corp.

Typewriter (Flexowriter)	8 char/sec
Paper Tape	60 char/sec
Magnetic Tape	7,500 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Tubes	450 for Elecom 125; 250 for 125 FP
Diodes	2,500 for Elecom 125 FP

95% of the tubes are of 2 types. Tube types used are the 6CL6, 12AT7, 5687, and the 5670.

CHECKING FEATURES

Manufacturer

Internal check for forbidden pulse combinations
Check of drum writing circuits
Parity check on tape with automatic re-read.
The Elecom 125 FP makes a parity check on all data.

Sandia Corp.

Magnetic tape circuits contain check to determine if block read contains same number of digits as block contained when written. Automatic re-read takes place if error is detected. The storage signals are continuously monitored for forbidden combinations.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	5-7 Kw
Volume, computer	400 cu ft
Weight, computer	4,000 lbs
Capacity, air conditioner	5 Tons

Volume and weight figures are for computer (complete) with control desk and three tape units. Room air conditioning is recommended. No built-in air conditioning is supplied with system.

Elecom 125 FP requires 7 Kw and occupies 200 cu ft, including control desk and 5 magnetic tape units. Five tons of room air conditioning is recommended. No built-in air conditioning is supplied with system.

Sandia Corp.

Power, computer	20 KVA
Power, air conditioner	2 KVA
Volume, computer	250 cu ft
Area, computer	50 sq ft
Weight, computer	8,000 lbs

Site preparation includes platforms over connecting cables, duct work over units to draw air through units for cooling, and normal dust prevention.

PRODUCTION RECORD

Manufacturer
(June 1957 figures)

Number produced	6
In production	2
Number in operation	6
On Order	3

System is no longer in production.

COST, PRICE AND RE...AL RATES

Manufacturer
(June 1957 figures)

	Price
Computer only	$155,000
Computer System with File Processor	350,000 to 450,000
File Processor only	85,000

	Monthly Rental
Computer only	$4,185
Computer System with File Processor	8,500 to 9,500
File Processor only	2,295

Sandia Corp.

Console, main frame, power supply, storage, tape drive (4 ea.), paper tape punch, Ferranti, paper tape reader, and Flexowriter cost $122,500.

Three Flexowriters are used at a total cost of $7,578.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Engineers	1	2	3
Tech & Operators	1	2	3

Above figures are the same for the File Processor.

Sandia Corp.

One operator, trained on the job, is required. Present use is primarily for engineering studies with job requestor operating facility himself.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Operating ratio (Good/Attempted to run) 0.90 to 0.95
Figures based on an eight-month period.

Above up-times (machine time available for problem work divided by total time) reported for 5 Elecom 120 computer installations. (Much of the Elecom 125 internal circuitry is substantially the same as that of Elecom 120). At one location, up times of 100% and 99.9% were obtained for two successive months.

Sandia Corp.

System is used very little at present time.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Two (2) four-digit base registers (B-boxes) are included as standard equipment.

An important partner in the Elecom 125 System is the Elecom File Processor. This is an entirely separate piece of equipment, designed and engineered to handle the sequencing, collating, extracting and similar operations necessary in day-to-day business applications.

The Elecom File Processor extracts from the voluminous "Library Tapes", the particular items upon which processing is to be done. It is the job of the Elecom File Processor to pick the pertinent items out of the tape file, so that the associated Computer wastes no time in "searching" through unwanted items. Once the items have been processed by the Elecom 125 Computer the Elecom File Processor puts them back into their proper place (in sequence) in the main file.

The picture shows the Elecom File Processor on the left, the Elecom 125 Computer on the right. The Magnetic Tape Units and the Magnetic Tape Interconnecting panel are in the rear. The Elecom High-Speed Line Printer is not shown.

FUTURE PLANS

Manufacturer

Elecom Universal Data Converter - A device for transcribing data between Elecom magnetic tapes and those of other manufacturers. In addition, the converter will be able to handle punched paper tape and punched cards. The converter is designed to make the Elecom 125 System, or the Elecom 125 Computer compatible with the input/output from it to any other data processing equipment currently manufactured.

INSTALLATIONS

(As of June 1957)
Sandia Corporation (2)
Albuquerque, New Mexico

Underwood Corporation (1)
Data Processing Center
New York City, New York

The Texas Company
Houston, Texas

Sylvania Electric Corporation (1)
Waltham, Massachusetts

FADAC

Field Artillery Digital Automatic Computer

MANUFACTURER

Autonetics Division
North American Aviation, Incorporated

Photo by U. S. Army

APPLICATIONS

FADAC -Field Artillery Digital Automatic Computer is a rugged, general purpose, portable computer developed under the sponsorship of Frankford Arsenal. FADAC design is based on the existing requirements for solving gunnery problems of tube artillery, free rockets, and missiles. Extreme versatility also enables solution of field artillery support computations related to surveying, counter battery, fire planning, flash and sound ranging, reduction of meteorological data, and master control and programming for automatic checkout of missile systems.

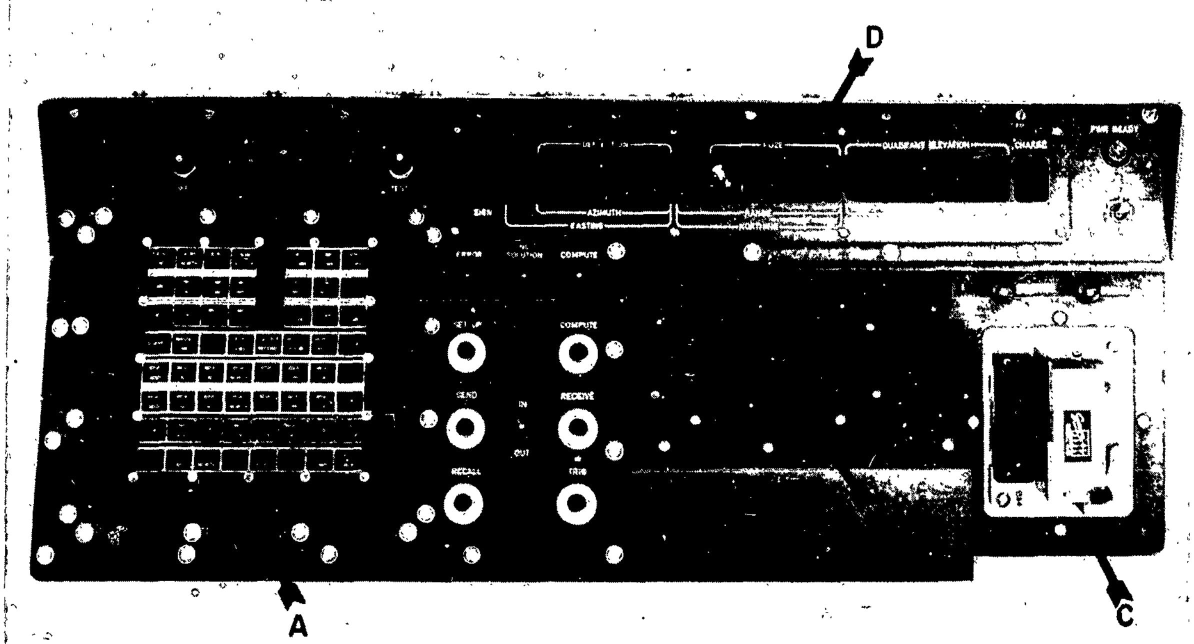
Mechanization of FADAC is based on solution of the differential equations of projectile motion from firing to impact. Necessary input data such as target location, powder temperature, gun location, meteorological data (inserted manually or by tape reader) are entered by means of a simplified keyboard. FADAC training time for experienced fire control personnel is extremely short. When all data are entered, depression of a button initiates computation; gun orders comprising deflection, quadrant elevation, fuze time, and charge are displayed in decimal form.

A high-speed automatic logic tester and a component tester are also available with FADAC; these are in addition to the self-checking features within the computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	35
Binary digits/instruction	35
Instructions/word	1
Arithmetic system	Fixed point
Instruction type	1 plus 1

Address of operand and next instruction



Control Panel of the FADAC Computer   Photo by U. S. Army

The matrix switches (A) allow the operator to enter fire control parameters or select prestored parameters. Depression of one button in the vertical row and one button in the horizontal row selects one of sixty-four locations and identifies one particular problem parameter. The manual keyboard (B) allows the operator to enter problem information for different type fire missions which has not been prestored in the memory. The mechanical tape reader (C) is used for entering the meteorological data which are contained on a punched tape. Final problem solutions are displayed on the 16 Nixie tubes (D).

Word format

1	1	2	31
Parity	Sign	Spacer	Numerical Absolute Value

Five 1-word registers for arithmetic and control
One 2-word register for output information storage
System is straight binary for internal operations with automatic conversions to other codes for input-output. Twos complement notation for negative numbers is used.

ARITHMETIC UNIT

Add time 7.8 Microseconds
Execution time for each instruction is 7.8 microseconds. High speed (2-bits at a time) multiplication, division and shifts.
Arithmetic mode Parallel by function
Serial by bit

Timing Synchronous
Pulse repetition rate 448,000 pulses/sec
Operation Sequential

STORAGE

Media	Words
Magnetic Disc (Main)	4,096
Magnetic Disc (Hi-Speed)	32

32 channels of 128 words each, of which 24 channels are designated as permanent storage and 8 channels as working storage.
The 32 words are two word high speed loops. Disc rotates at 6,000 rev/min and its storage is non-volatile.

INPUT

Media	Speed
Keyboard	Manual
Paper Tape	Mechanical
Paper Tape	700 char/sec
Gunnery Off Console	Manual
Another FADAC	
Magnetic Tape	
Other FIELData Equipment	
Teletype	

Five or eight channel paper tape, 5-level teletype or FIELData code. Automatic conversion to machine language provided. Maximum inputrate is 4,250 char/sec.

OUTPUT

Media
Visual Display (Nixie)
Signal Level (Console)
Another FADAC
Battery Display
Printer
Magnetic Tape
FIELData Equipment
Teletype Equipment

System provides information in either 5-level teletype, 2-wire teletype, or FIELData codes. Maximum output rate is approximately 4,250 characters per second.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Transistorized

CHECKING FEATURES

Parity check on FIELData information transfer.
Verify feature on input in program-full mode.
Marginal test provision for preventive maintenance.
Voltage transient and temperature warning indicators.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer 0.700 Kw

Three phase, 4-wire, 400 cycles/sec, 120/208 volts. Automatic power loss interlocks and phase reversing features are provided.

Volume, computer 5 cu ft
Weight, computer 175 lbs

System operates from -25°F to 125°F (external ambient at sea level). Capable of operating to -40°F with kit. Automatic temperature protection is provided.

ADDITIONAL FEATURES AND REMARKS

Additional features include logic provision for expandable memory; standardized etched boards utilized for reduction of logistics problems; ruggedized for field use; system design provides auxiliary equipment on an integrated basis for computer memory loading, automatic computer testing, and subassembly maintenance, and peripheral equipment for additional operator control in program checkout.

FOSDIC

Film Optical Sensing Device for Input to Computers

MANUFACTURER

U. S. Department of Commerce
National Bureau of Standards

Photo by the Bureau of the Census

APPLICATIONS

System is utilized for the reading and conversion of microfilm copies of Decennial Census Schedules (position marked documents) to magnetic tape for computer input.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Number bin cod dec dig/word	Variable
Number instructions decoded	45
Arithmetic system	None
Instruction type	Plugboard

FOSDIC converts coded marks on microfilmed documents to information on magnetic tape in the following manner: (1) A flying spot scanner tube is programmed to make several calibration tests on each document measuring dark level, light level, tilt, horizontal and vertical reduction ratios. (2) The beam is then programmed using major and minor jump instructions (coordinate increases or decreases) to locate 1/4" black reference marks called "indexes". (3) From a given index, program steps then positions the beam over each possible marking position, measuring light output and interpreting the result as either an "answer" or "no answer". (4) The most dominant (darkest) of the answers is held in memory until all positions for a given question have been scanned. This answer (as coded by the program plugboard) is written on magnetic tape. (5) Magnetic tape format is UNIVAC compatible, 100 pulses/inch, 720 character blocks in fixed format. The FOSDIC internal word and frame lengths are variable, however, and many formats (number of frames per block, number of digits per word) are possible under program control.

STORAGE

Temporary fast storage by means of flip-flops.

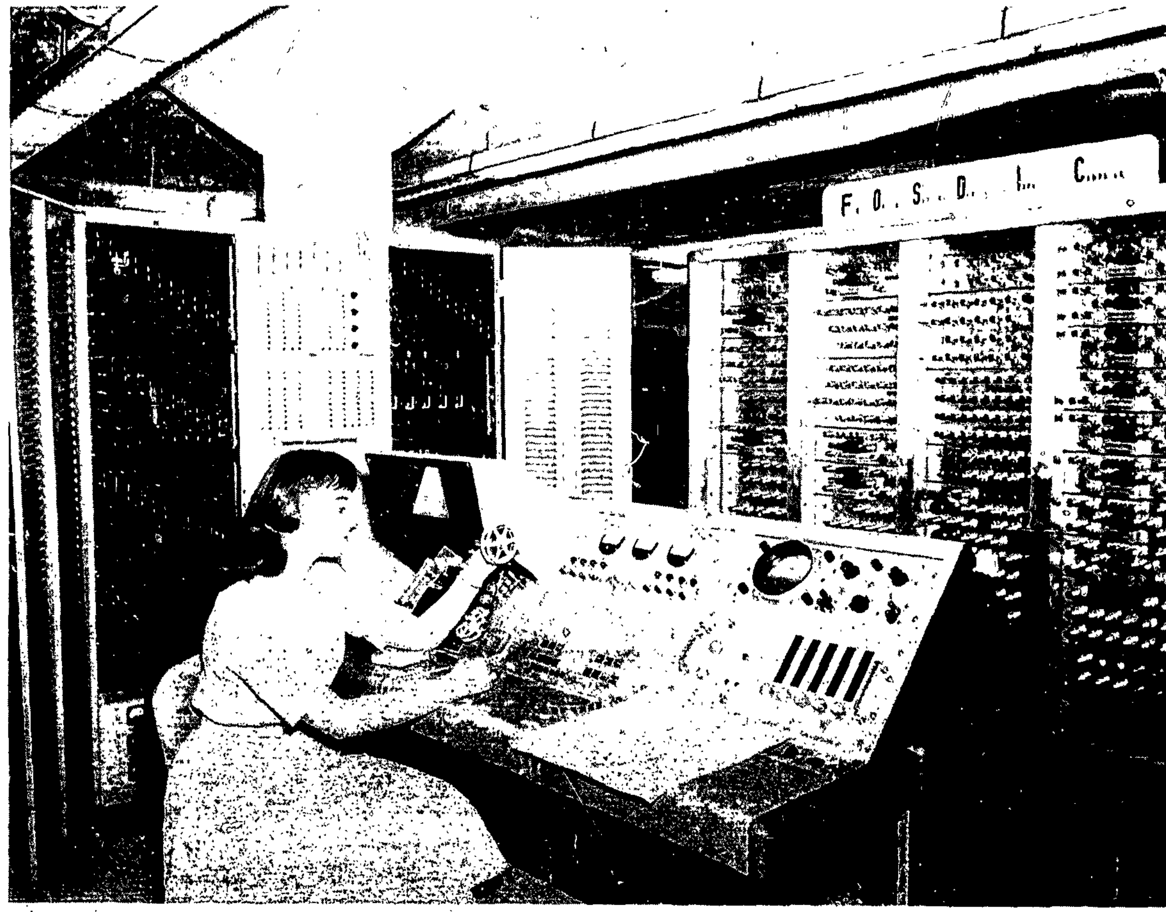


Photo by the Bureau of the Census

INPUT

Medium	Speed
Microfilm	2 - 4 frames/sec

Flying spot tube scanning

OUTPUT

Medium	Speed
Magnetic tape	2,376 char/sec

Speed depends on amount of document information

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	1,200
Diodes	2,000
Transistors	3,000

FOSDIC consists of a Scan Unit constructed of vacuum tubes, cathode ray tubes, photocells, magnetron beam-switching tubes, and conventional point-to-point wiring; and a Program Control Unit constructed of solid-state components, transistors, diodes, etc., mounted ... printed circuit boards.

CHECKING FEATURES

Numerous scan, magnetic tape and program interlocks, sprocket and parity checking on magnetic tape output are utilized.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	5 Kw	5 KVA	1.0 pf
Volume, computer	3,000 cu ft		
Area, computer	300 sq ft		
Room size, computer	20 x 20 x 10 ft		
Floor loading, computer	140 lbs/sq ft		

Figures are for each system. Air conditioner is part of integrated system.

Site preparation included alteration of area from previously subdivided sections onto single enclosed area; provision of air ducts and space air conditioning equipment; alteration of lighting fixtures; provision of power consuits and outlets; fire wall construction.

PRODUCTION RECORD

Number produced to date	5
Number in current operation	4
Number in current production	4

FOSDICs currently manufactured by Bureau of the Census personnel for their own production needs.

COST, PRICE AND RENTAL RATES

Total cost for development and construction of 5 FOSDIC systems with 1 magnetic tape unit each
$633,000

PERSONNEL REQUIREMENTS

	Three 8-Hour Shifts
Supervisors	3
Analysts	
Programmers)	3
Coders	
Engineers	2
Technicians	10
In-Output Oper	12

Operation tends toward open shop.

Methods of training used
Training branch conducts formal classroom sessions for programmers, operators (followed by on-the-job training) executive orientation, brush-up seminars. Classroom and on-the-job training also conducted for engineers and technicians.
Programmers are customer employees.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Date this system passed Acceptance Test Sep 59-Mar 60
Time is not available for rent to outside organizations.
Each system is operated an average of about 100 hours per week, excluding scheduled maintenance.

ADDITIONAL FEATURES AND REMARKS

Prior to the invention of FOSDIC the bulk input medium has generally been punch cards but a few figures showing our experience in 1950 points out certain of their limitations. At that time we used a force of nearly 2000 key punch operators at the peak of operations, and over 14 months was needed at a cost of almost six million dollars just to record the enumerated population and housing data on cards.

These facts led Census back to the Bureau of Standards for additional study and review of the input problem. Out of this interchange grew FOSDIC I. The name is an abbreviation of Film Optical Sensing Device for Input to Computers. Designed and built for Census by the Bureau of Standards, it promised a breakthrough in the input problem area.

The principle was based on field documents being position coded (by checking the proper box), microfilming the documents, and scanning the microfilm with an electronic beam. The detected position codes are written on the magnetic tape which is our computer input medium.

This early model FOSDIC served Census well. Several special tasks were successfully processed through its use. Its chief contribution, however, was in showing the way to a more versatile, faster, less restrictive system. Subsequently, Bureau of Standards and Census engineers collaborated on a successor, FOSDIC III. In the meantime, the Bureau of Standards had produced FOSDIC II which is used by the Weather Bureau to do a high-speed search on large punch card files which have been reduced to microfilm.

FOSDIC III captured our imagination. It features a completely programmable scan, permits tremendous flexibility in schedule and questionnaire design, and has such features as automatic calibration on each microfilm frame measuring dark level, light level; compensation for tilt or non-parallelism due to photography or printing; compensation for size variation in the filming reduction process; blank line elimination (conditional jumps over partially-filled out documents); and dominant mark, an ability to choose the darkest of several competing marks, thus eliminating the problem of erasures. It is plugboard programmed and has about 45 instructions and program loops. Iterations are possible as with internally-stored program computers. Documents are limited only to be 20" x 14" or less, and their microfilm counterparts will be translated to programmer-chosen codes on magnetic tape at about 100 frames or documents per minute. This works out to an average character rate of about 19,000 - 24,000 characters per minute. A tough rate for a key punch operator to match.

The 1960 Decennial Census

The equipment utilized 5 FOSDIC systems consists of:
4 Univac Scientific 1105 Computers with 18 tape units each, 2 Univac I Computers with 10 tape units each, 2 600 lines per minute High-Speed Printers, equipped with Block Buffers, 1 Card-to-Magnetic Tape Converter, and a host of miscellaneous auxiliary equipment of a minor nature.

Adopted procedures for magnetic tape handling include fire wall construction; metallic containers for magnetic tape, fire fighting organization and training, control system for defective and damaged tapes, and standardization of tape reel lengths and markings.

INSTALLATIONS

Bureau of the Census
Washington, D. C.

GE 100 ERMA

General Electric 100 Electronic Recording Method Accounting

MANUFACTURER

General Electric Company
Computer Department
Phoenix, Arizona

Photo by Bank of America (Abbate Photo)

APPLICATIONS

Located in San Francisco, Berkeley, San Jose, Los Angeles, North Hollywood, Covina, and Paramount, California, the systems are being used for commercial deposit accounting (checking accounts). The Bank of America is now operating 7 ERMA Centers in the locations indicated above. Each center is equipped with 2 to 3 GE-100 Computing Systems depending on projected account volume for area being serviced. Checks and deposits, which are delivered to the ERMA Centers in the early evening, are processed and sorted at night for early morning return to the branches.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4,000	28,000	32

Work structure consists of 7 decimal characters. The first character contains sign, numeric-alpha numeric designation and checking digits.

INPUT

Media	Speed
Magnetic Tape	30,000 char/sec

3/4 inch tape - 10 channel - 2 digit in parallel.

Paper Tape	200 char/sec

7 channel punch paper tape photo reader

Flexowriter	10 char/sec

7 channel punch paper tape mechanical reader

Sorter/readers	750 items/min

Magnetic ink coded documents. The sorter/readers are equipped with character recognition.

OUTPUT

Media	Speed
Magnetic Tape	30,000 char/sec
Flexowriter	10 char/sec
Printer	600-900 lines/min

Revolving drum/hammer type, operable both off-line and on-line. The printer is used off-line with magnetic tape input.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	150 Kw
Power, air conditioner	185 Kw
Volume, computer	18,000 cu ft
Volume, air conditioner	33,500 cu ft
Area, computer	2,000 sq ft
Area, air conditioner	1,900 sq ft
Room size, computer	80 ft x 25 ft x 9 ft
Room size, air conditioner	87 ft x 20 ft x Mezzanine
Floor loading	250 lbs/sq ft
Capacity, air conditioner	150 Tons
Weight, computer	23,000 lbs

False ceilings and plenums are required for air supply and negative pressure. Building type is either of pre-stressed concrete panels or cast concrete: no modifications are necessary since the buildings are specifically designed as ERMA Centers. Power distribution is provided by underfloor conduit and pull boxes.

PERSONNEL REQUIREMENTS

Because of the recent development and installation of our current GE 100 Systems, accurate figures are not yet available on our ultimate personnel requirements. However, typical operating personnel in an ERMA Center consist of a manager, assistant managers, branch liaison officers, console operators, sorter/reader operators and printer operators. Programming activities for all our various installations are centralized within the Bank of America's Systems and Equipment Research Department. Engineer and technician requirements are to be determined by the manufacturer, General Electric Company, under terms of the contractual agreement to provide necessary maintenance.

Operation tends toward open shop.

Key personnel, i.e. managers, liaison officers and console operators receive a six-month training course prior to their initial assignment. The first seven weeks consist of attendance at a programming school. The remaining weeks are spent in controlled on-the-job training in all phases of an ERMA Center's operation. All other employees are given on-the-job training in their respective assignments.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	2 Hours
Good time	60 Hours/Week (Average)
Attempted to run time	62 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.967

Above figures based on period 1 Aug 60 to 31 Aug 60

Passed Customer Acceptance Test 1 Jul 59

Time is available for rent to qualified outside organizations. Although we have available computer time now, it is not being offered on a rental basis due to our projected volume which will utilize this time.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include magnetic ink character recognition and simultaneous read one tape, write one tape, and compute is permitted. Magnetic ink character recognition units on the sorter/readers allow computer input directly from source documents.

Magnetic tapes receive an internal label under program control as well as a manually produced external label. Tapes are stored in a fire-proof tape vault which has humidity and temperature control. Critical "back-up" tapes are sent daily to off-premise storage locations.

The system was designed by General Electric as a general purpose computer to be used primarily in deposit accounting. Therefore, in order to utilize source documents as immediate input, the system was provided with magnetic character recognition facilities rather than punched card input.

Components of a basic system are a central processing unit, main power unit, console, eight tape units, tape control unit, printer, printer control unit, three sorter/readers, and a sorter/reader control unit.

Under the term of the sales contract, cost/price figures per system will not be available prior to equipment acceptance at final installation.

FUTURE PLANS

Additional ERMA Centers are planned to service the branches of the Bank of America in the Sacramento, Fresno, West Los Angeles, Southwest Los Angeles, Montebello, and San Diego areas. It is anticipated that these centers will all be in operation by June 30, 1961.

Due to the fact that our ERMA Centers are either relatively new or still in the planning stage, and since the equipment has yet to be utilized to the maximum extent of which it is capable, no additional components, major modifications or plans for retirement are under consideration at the present time.

INSTALLATIONS

Bank of America NT & SA
Systems and Equipment Research Department
500 Howard Street
San Francisco, California

GE 210

General Electric Model 210

MANUFACTURER

General Electric Company
Computer Department

Photo by General Electric Company

APPLICATIONS

Manufacturer

System is designed for general purpose, commercial, data processing and utility billing applications.

Computer Department, General Electric

System is used for banking, utility billing, and inventory

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal
Decimal digits/word	6
Decimal digits/instruction	6
Instructions/word	1
Instructions decoded	124
Arithmetic system	Fixed point
Instruction type	One address
Number range	-999,999,999,999 to +999,999,999,999

Instruction word format

	Operation Code	Operand Address

There are automatic built-in subroutines. A complete library of subroutines for business data processing is available.

G. E. Com. and General Electric Common Language (Common to all G. E. Machines) including Automatic Coding Techniques and Assembly Compiler are available.

Registers

N	Location of next instruction
M	Input & output memory transfer
J	Memory Buffer
I	Contains current instruction
R	Accumulator

L	Used with R for double length word operations
B	Address portion on instruction
P	Peripheral Buffer

ARITHMETIC UNIT

Manufacturer

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	64	32
Mult	550 Aug.	518
Div	1200 Aug.	1168

Construction (Arithmetic unit only)

Transistors	9,998
Condensers	7,430
Diodes	39,333
Arithmetic mode	Serial
Timing	Synchronous
Operation	Concurrent

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Core Memory	4,000 or 8,000	24,000 or 48,000	32
Magnetic Tape	1,400,000	8,400,000	5000

No. of units that can be connected	13 Units
No. of chars/linear inch	66 Chars/inch
Channels or tracks on the tape	11 Tracks/tape
Blank tape separating each record	1 Inch
Tape speed	60 or 100 Inches/sec
Transfer rate	30 to 50 KC Chars/sec
Start time	4.5 Millisec
Stop time	4.5 Millisec
Average time for experienced operator to change reel	30 Seconds
Physical properties of tape	
Width	3/4 Inches
Length of reel	1200, 2400, 3600 Feet
Composition	Mylar

INPUT

Manufacturer

Media	Speed
Magnetic Tape	30 or 50 char/sec
Magnetic Documents	750 or 1200 documents/min
Paper Tape	200 or 500 char/sec
Punched Cards	400 or 1500 cards/min
Console Typewriter	10 char/sec

OUTPUT

Manufacturer

Media	Speed
Magnetic Tape	30 or 50 char/sec
Magnetic Documents	750 or 1200 documents/min
Paper Tape	60 char/sec
Console Typewriter	10 char/sec
High Speed Printer	72 Column 600 (Alpha) lines/min 1200 (Numeric) lines/min 120 Column 600 to 1000 lines/min E13B Magnetic Font (off line) 300 lines/min

CHECKING FEATURES

Manufacturer

Internal checking is performed on all operations by the Modulo-3 method.

A 2-way parity check is performed in all magnetic tape operations.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

KVA, computer	10 KVA	208v
Area, computer	50 sq ft	
Room size	680 sq ft	
Floor loading	150 lbs	
Weight, computer	10,000 lbs	
Capacity, air conditioner	7 Tons	

Computer Department, General Electric

KVA, computer	40 KVA
Area, computer	1100 sq ft
Floor loading	250 lbs concen max
Weight, computer	9,650 lbs
Weight, air conditioner	central

Site preparation included a false ceiling and floor, and brick construction.

PRODUCTION RECORD

Manufacturer

Number produced to date	8
Number in current operation	8
Number in current production	8
Number on order	50
Time required for delivery	12 - 15 months

COST, PRICE AND RENTAL RATES

Manufacturer

Basic system	Cost
Central Processor	$225,000

PERSONNEL REQUIREMENTS

Manufacturer

Entirely dependent on application and utilization.

Training made available by manufacturer to users includes complete training in all aspects of electronic data processing - programming classes, operator training, and consultation service. Full time site application engineer assinged to customer from time of order until 3 months after installation.

Computer Department, General Electric

	One 8-Hour Shift
Supervisors	1
Analysts	2
Programmers	2
Coders	3
Clerks	8
Librarians	1
Operators	2
Engineers	4
Technicians	2
In-Output Oper	5

Operation tends toward open shop.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Large scale computer fully transistorized and proven by 1 1/2 years of continuous daily operation in processing an actual application.

Computer Department, General Electric

Average error-free running period	95%
Good time	35 Hours/Week (Average)
Attempted to run time	40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	95%
Passed Customer Acceptance Test	June 59

Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include automatic address modification, blockette write, table look-up command, special commands for internal sorting, and ease of programming.

Unique system advantages include dual document handlers on-line; automatic Mod-3 and parity check, and simultaneous read/write/compute ability.

Computer Department, General Electric

System is completely solid-state. It has the ability to read ABA E13B Font.

Magnetic tapes are stored in vaults and fireproof cabinets.

FUTURE PLANS

Manufacturer

Future plans for this system include thermo plastic tape storage, broader use of magnetic ink, and character reading.

INSTALLATIONS

General Electric Company
Computer Department
13430 North Black Canyon Highway
Phoenix, Arizona

GE 225

General Electric Model 225

MANUFACTURER

General Electric Company
Computer Department

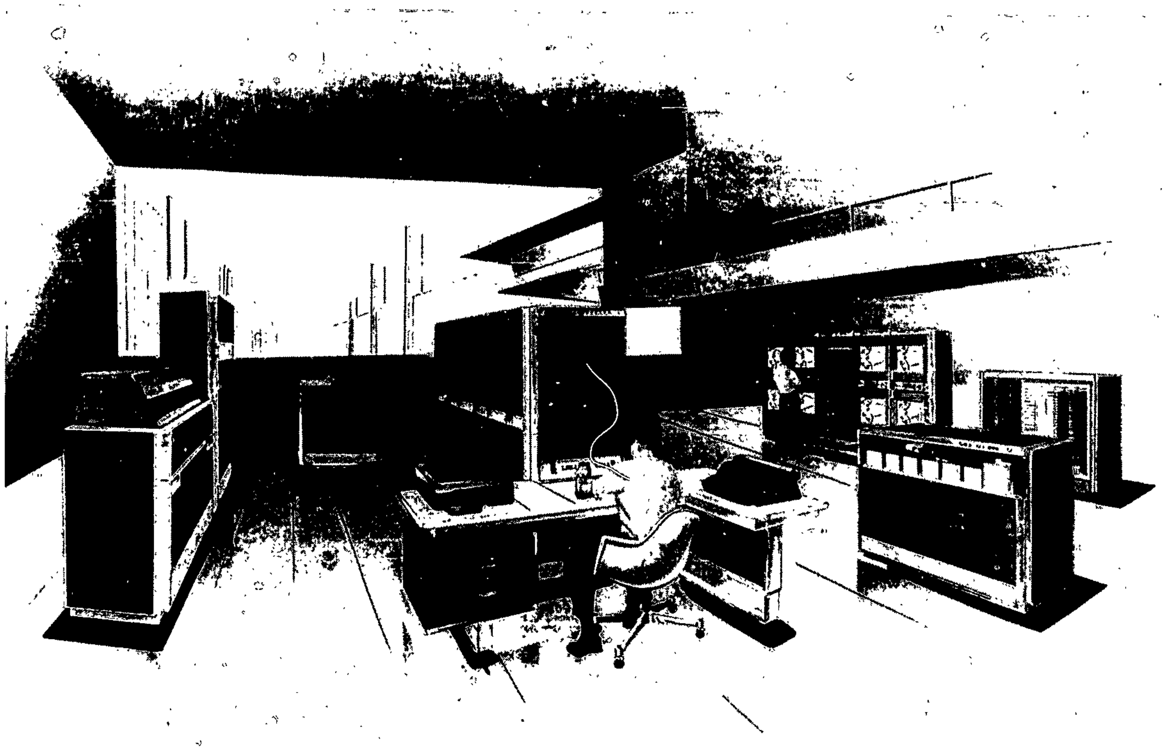


Photo by General Electric Company

APPLICATIONS

System is designed for business data processing, business paper processing, and scientific computing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary	
Binary digits/word	(19 + sign) = 20	
Instructions/word	One	
Instructions decoded	59 plus input and output	
Arithmetic system	Floating point	optional
	Fixed point	standard
Instruction type	One address	

Instruction word format

4	5 6	7
Operation Code	Address Modification Bits	Operand Process

Automatic built-in subroutines include double precision add and subtract. Standard double precision multiply and divide are optional.

The standard GE 225 is equipped with a compiler which is an automatic coding technique which allows the program to be prepared with little or no knowledge of the intricacies or internal language of modern computers.

Registers

A Register	an accumulator
Q Register	used for double length operations
M Register	memory location
N Register	output register for typing
I Register	instruction register
B Register	memory buffer, holds information during arithmetic operations
P Counter	instruction counter

GE 225 accomodates alphabetic or numeric, binary or decimal information.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	40	20
Mult	250	230
Div	500	480

Construction (Arithmetic unit only)

Transistors	3,194
Condensers	4,747
Diodes	4,183
Magnetic Cores	327,680

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

System is concurrent in that input-output equipment operates simultaneously with central processor, which performs calculations. This substantially reduces processing time.

STORAGE

Media	No. of Binary Words	Access Microsec
Magnetic Core	2048, 4096, 8192 or 16,384	20
Magnetic Drum	8192 or 16,384 20-bit words	8,300

Magnetic Tape

No. of units that can be connected	64 Units
No. of chars/linear inch	200 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	3/4 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Chars/sec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	1/2 Inch
Length of reel	2,400 or 3,600 Feet (Max)
Composition	Mylar

The tape language is compatible with most existing tape installations.

INPUT

Media	Speed
Magnetic Tape	15,000 char/sec
Horizontal and vertical parity checking	
Document Sorter	1,200 docum/min
Sorter under control of central processor	
Paper Tape Reader	1,000 char/sec
Parity check	
Card Reader	400 cards/min
Reads binary or Hollerith CD. Photoelectric	
Control Console	

OUTPUT

Media	Speed
Console Typewriter	10 char/sec
This is under the control of the central processor	
Card Punch	100 cards/min
Punches binary or Hollerith cards	
High Speed Printer	600 lines/min
Flexible print format-parity check	
Magnetic Tape	15,000 char/sec
Horizontal and vertical checking	
Punched Paper	60 char/sec
5, 6, 7, 8 channel tape	
Data Transmitter - Receiver Unit	60 char/sec

CHECKING FEATURES

Parity checking

POWER, SPACE, WEIGHT, AND SITE PREPARATION

KVA, computer	15
Room size	1,200 sq ft
Capacity, air conditioner	3 Tons
Weight, computer	8,900 lbs

PRODUCTION RECORD

Time required for delivery from receipt of order 12 months

COST, PRICE AND RENTAL RATES

Basic System	Cost
Central Processor	$200,000 or $4,000/mo.

PERSONNEL REQUIREMENTS

Entirely dependent on application and utilization.

Training made available by manufacturer to users includes complete training in all aspects of electronic data processing - programming classes, operator training, and consultation service. Full time site application engineer from time of order until 3 mos. after installation.

ADDITIONAL FEATURES AND REMARKS

The data mating function of GE 225 provides a common control and inter-communication link for the wide range of either data processing peripheral units or unusual special purpose input-output devices associated with the system.

A general compiler provides the programmer with a highly advanced and effective automatic coding technique.

The equipment flexibility of the GE 225 offers an additional degree of freedom in the planning of a system by allowing the computer to grow to meet the demands of expanding systems requirements.

INSTALLATIONS

General Electric Company
Missile and Space Vehicle Department
3198 Chestnut Street
Philadelphia 1, Pennsylvania

GE 250

General Electric 250 Information Searching Selector

MANUFACTURER

Computer Department
General Electric Company

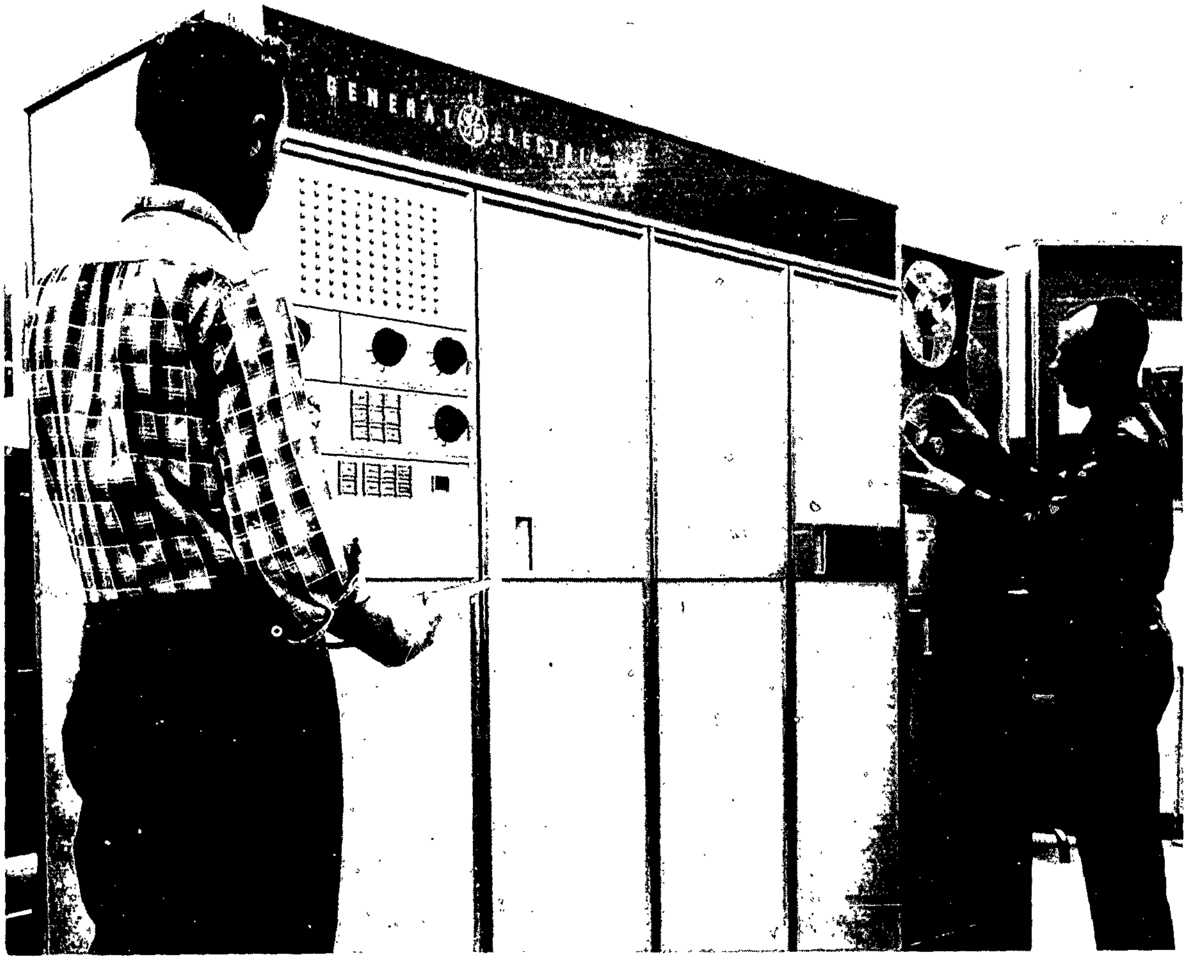


Photo by Computer Department, General Electric Company

APPLICATIONS

The GE 250 Information Searching Selector is a data processing system specifically designed to provide rapid inquiry and selection from large data files.

In its simplest form, the Information Searching Selector provides: storage of information, storage of the search questions, and the means for comparing the two, detecting desired information, and recording the result.

The information file is stored on magnetic tape which provides a compact record with unlimited expansion. Search questions are stored in the memory of the Selector. Whenever search questions are satisfied, answers are recorded.

It can be used to retrieve information from vast files of data as found in: industry (chemicals, metals, petroleums, pharmaceuticals), government (patents, military, personnel, intelligence, law enforcement, census), and the professions (law, medicine, applied research, libraries).

The first GE 250 Information Searching Selector will be delivered to the Center for Documentation and Communications Research at Western Reserve University. It will be used to accelerate the abstracting service of a metals information center now in operations, as well as to facilitate further effort into other documentation and library research - including language translation.

PROGRAMMING AND NUMERICAL SYSTEM

Up to ten inquiries may be prepared on punched paper tape and entered into the Selector's main memory for simultaneous processing. Successive reels of magnetic tape file are searched at the rate of 15,000 characters per second for satisfaction of any or all of the ten inquiries. Each tape may contain four million or more characters.

A printed text or identifying information is provided in answer to all selected questions and the search criteria they fulfill. If desired, acceptance through partial satisfaction of requirements can be specified.

The GE 250 Information Searching Selector retrieves selected information from a large storage file, permits immediate and efficient use of recorded knowledge, answers questions through high-speed electronic searching, correlates scattered information in complex files, reduces costs of file preparation and searching, and simplifies updating of information with new material - simplifies elimination of obsolete information.

ARITHMETIC UNIT

System reviews and compares 15,000 char/sec.

Several thousand abstracts can be processed per minute.

Up to ten unrelated inquiries can be searched simultaneously.

STORAGE

Magnetic Tape	15,000 char/sec
Buffer Storage	Expansible

Number of magnetic tape units is variable.

INPUT OUTPUT

Media	Speed
Magnetic Tape	15,000 char/sec
Cards	Read-punch unit

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

System is fully transistorized.

CHECKING FEATURES

Adequate checking provides accuracy.

ADDITIONAL FEATURES AND REMARKS

The GE 250 Information Searching Selector can operate with any indexing, classifying or coding system-even simple English notation. Professional assistance will be provided for developing systems and adapting well-tested procedures.

Outstanding features are that it is compact, easy to install, and easy to operate. It requires little power as it is fully transistorized.

FUTURE PLANS

The first Information Searching Selector will be used by Western Reserve University, Center for Documentation and Communication Research, to provide rapid inquiry and selection of information from vast data files.

INSTALLATIONS

Western Reserve University
Center for Documentation and Communication Research
Cleveland, Ohio

General Electric Company
Computer Department
Deer Valley Park
Phoenix, Arizona

GE 312

General Electric Model 312

MANUFACTURER

General Electric Company
Computer Department

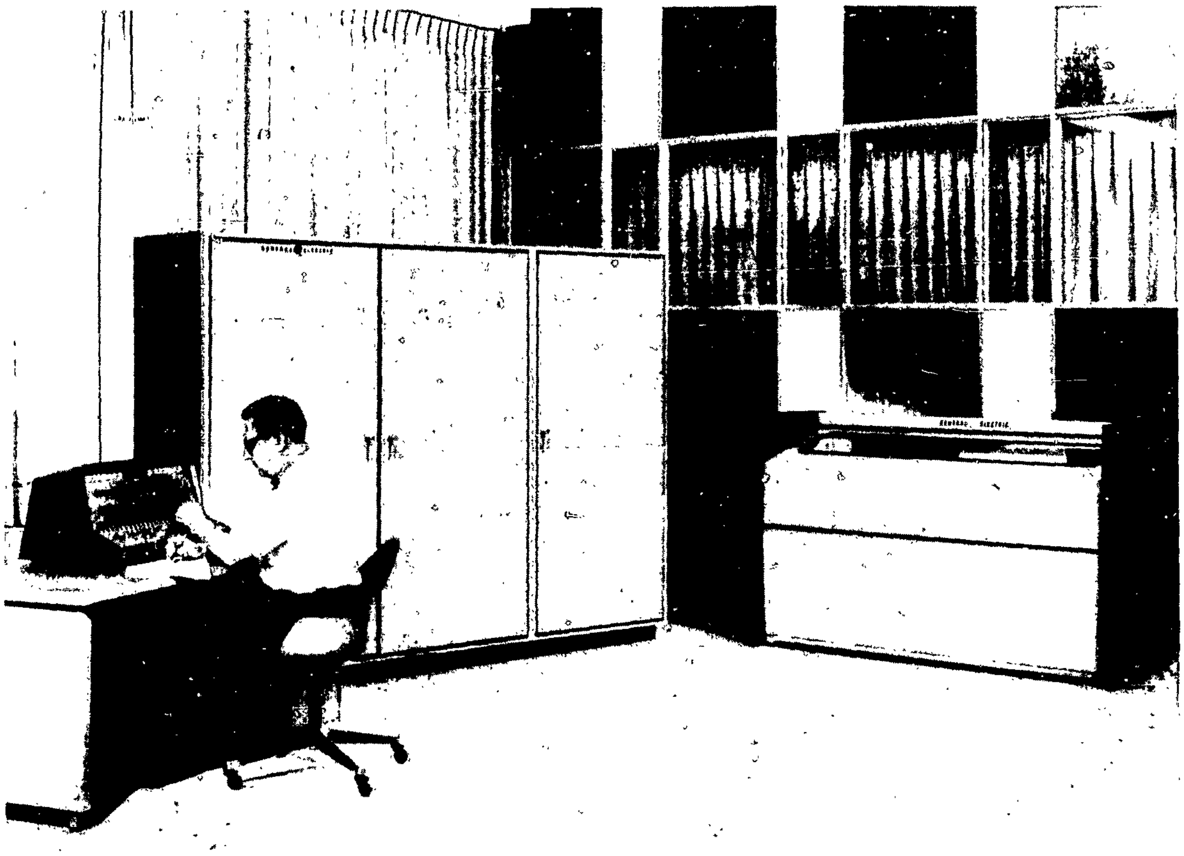


Photo by General Electric Company

APPLICATIONS

System is designed for process and production control as well as for data logging and monitoring.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20 19 + Sign
Binary digits/instruction	19
Instructions/word	Single address or 1+1 Mode
Instructions decoded	More than 60
Arithmetic system	Fixed point
Instruction type	One address
Number range	-524,288 to +524,288

Instruction word basic format

1	2 5	6 19
	Command	Operand Address

An eleven bit automatic modification of instruction address is provided for automatic instruction modification, linkage for sub-routines, counters, etc.

Registers

A	Primary Arithmetic Register
Q	Arithmetic and Temporary Storage
N	I/O Buffer
X	Instruction Modification
X	Current Instruction
B	Location of Next Instruction

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	192(1 Add) 288(1+1 Add)	96
Mult	2016 Max (1+1)	1920 Max
Div	2592 Max (1+1)	2496 Max

Construction (Arithmetic unit only)

Transistors	2,572
Condensers	1,409

Diodes	2,265
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	Access Microsec
Magnetic Drum	2,048 to 50,000	6,250 avg

Optional: Fast Access Core Storage can be provided.

INPUT

Media	Speed
Paper Tape Reader Standard equipment	20 char/sec
Paper Tape Readers Optional equipment.	Up to 240 char/sec Additional or alternatives.
Process Analog and Digital Information Requires optional equipment	

When coupled to process instrumentation, analog or digital inputs may be accommodated within limits which virtually are determined only by the requirements of the users.

OUTPUT

Media	Speed
Paper Tape Punch Standard equipment	20 char/sec
Electric Typewriter Standard equipment	10 char/sec
Paper Tape & Card Punch Optional	60 char/sec
Analog Output (Digital-to-Analog Converter)	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
HD2160	445
1H1692	32
HD2231	1,788
Transistors	
2N219	2,290
2N321	51
2N527	135
2N388	96

CHECKING FEATURES

Parity checking

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	4 Kw	120v ± 10%	60 cps
Volume, computer		168 cu ft	
Area, computer		27 sq ft	
Floor loading		110 lbs/sq ft	
Weight, computer		3,000 lbs	
Air conditioner		Self contained 105°C max, 95% humidity	

PRODUCTION RECORD

Number produced to date	4 (1 Aug 60)
Number in current operation	4
Number in current production	12
Number on order	12
Time required for delivery	8-12 months

COST, PRICE AND RENTAL RATES

GE 312 Digital Control Computer System Standard Basic Price with 8,000 word drum memory	$85,200
In usual applications the GE 312 is used as Central Processor for On Line Data Processing & Computer Control Systems for utility & industrial plants, depending upon the system configuration.	Price range from $150,000 to $500,000

PERSONNEL REQUIREMENTS

Completely dependent upon application.
Training made available by manufacturer to users includes a 3 week programming course and an 8 week maintenance course. Following the 3 and 8 week courses, is on-site training during installation and initial operation.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

On-Line reliability of 99% over a 6 month period.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include up to 52,000 word drum memory expansion, single & 1 + 1 address, and automatic address modification.

Unique system advantages include a flexible command structure, including a special instruction for computer direction of system input/output equipments.

GENERAL MILLS AD/ECS

MANUFACTURER

General Mills AD/ECS Computer

General Mills
Mechanical Division

Photo by General Mills

APPLICATIONS

System is a general purpose digital computer, which may be used for on-line and real time applications as well. System can communicate with conventional digital I/O, as well as A/D converters, and other buffering equipment.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36 + sign
Binary digits/instruction	18
Instructions per word	2
Instructions decoded	Up to 64
Arithmetic system	Fixed point (Floating optional)

Data processing is in alphanumeric

Instruction type	One address
Number range	$-(1-2^{-36})$ through $+(1-2^{-36})$

Instruction word format

	Instr I		Instr II	
Break-point	Oper	Address	Oper	Address
1	6	12	6	12

Instructions are not permanently designed into the machine, but are constructed from microprogrammed "instructions" by means of placing appropriate diode logic on a special circuit card called an "instruction card". Many specialized orders can be constructed using this technique.

One index counter is standard. There are up to 8 additional index counters available as an option.

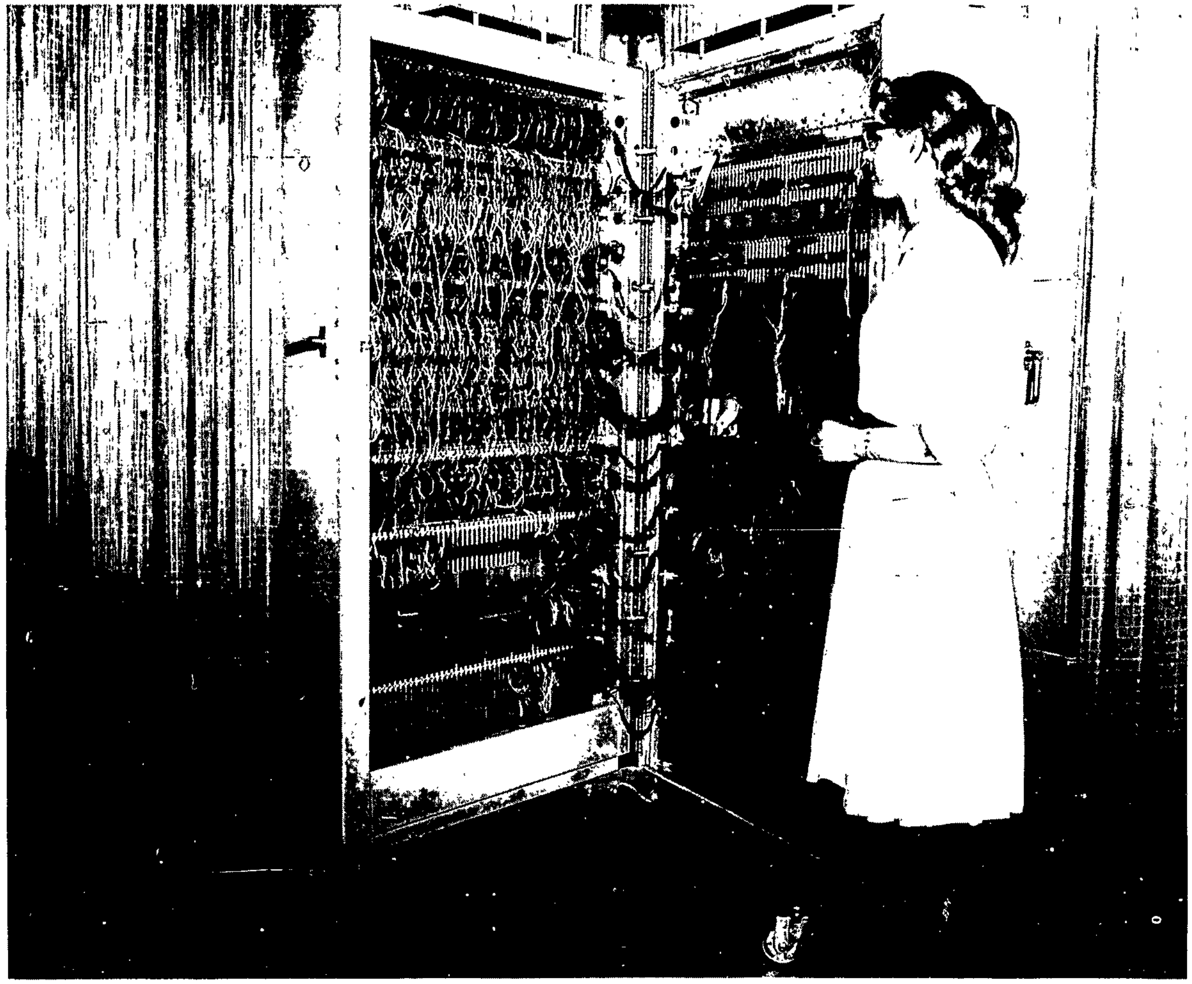


Photo by General Mills

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	80	60
Mult	840	800
Div	940	920

Construction (Arithmetic unit only)
  Transistors 1,000
  Diodes 10,000
Arithmetic mode Parallel
Timing Asynchronous
Operation Sequential
  System is entirely solid state.

STORAGE

Media	No. of Words	No. of Digits/Word	Access Microsec
Magnetic Core	4,096	36 bits + sign	8
Magnetic Drums (optional)	10,000	36 bits + sign	8,000 (avg)

Magnetic Tape
 No. of units that can be connected 64 Units

No. of chars/linear inch of tape	200 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	150 Inches/sec
Transfer rate	30,000 Chars/sec
Start time	5 Millisec
Stop time	5 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,100 Feet
Composition	3M 186 magnetic instrumentation tape

INPUT

Media	Speed
Paper Tape	150 char/sec
Typewriter	12 char/sec

Paper tape is standard but computer can also accommodate a wide variety of other input devices, e.g. cards. Unit will read any code one 8 bit character at a time or std word or block.

OUTPUT

Media	Speed
Paper Tape	60 char/sec
Typewriter	12 char/sec

Paper tape is standard but computer can also accommodate a wide variety of other output devices, e. g. cards, printers. Unit will punch any code one 8 bit character at a time or std word or block. Alphanumeric with format control.

Paper tape units will handle data in any format up to 8 levels. System is capable of handling up to 64 input-output devices of almost any sort. These devices could exchange information with two 64-word magnetic core buffers at the normal input-output device information rate. The central computer initiates these external machine and buffer operations but does not wait for their execution. The AD/ECS goes on with other computation while buffer operations are proceeding and then takes in the buffer information at the central computer rate.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	15,000
Transistors	1,500
Magnetic Cores	37,000; 74,000; or 148,000

System is entirely solid state. Quantity of magnetic cores is dependent upon the memory option.

CHECKING FEATURES

Parity check on all input-output. Marginal checking on frequencies and voltages.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1 Kw
Volume, computer	65 cu ft
Area, computer	10.5 sq ft (not including console)
Floor loading	60 lbs/sq ft
Weight, computer	600 lbs

No special site preparation or air conditioning required.

PRODUCTION RECORD

Number produced to date	2
Number in current operation	2
Number in current production	1
Number on order	1
Time required for delivery	6 months

COST, PRICE AND RENTAL RATES

Basic System	Cost
Paper Tape Reader (150 char/sec)	$ 3,932
Paper Tape Punch (60 char/sec)	3,283
Central Computer	109,956
Typewriter	12,952
Console plus Desk	11,857
Total	$ 141,980
Additional Equipment	
Floating point	$ 3,200
Extra index, counters: 1 through 4	760 plus 1,930 each
5 through 8	1,520 plus 1,930 each
Binary to BCD and BCD to binary instruction cards	155 each
Bin to alphanum and alphanum to bin instruction cards	205 each

Not available for rent.

On-site or on-call maintenance is available.

PERSONNEL REQUIREMENTS

Programming and, if desired, maintenance training courses are available. Personnel requirements depend on application and size of system.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Completely transistorized. Designed to work without air-conditioning in range of 32° F - 125° F. System constructed of very few basic building blocks. Has operated reliably outdoors for extended (months) periods.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include the ability to have extremely flexible order structure, due to instruction card principle, flexible external machine communications, magnetic core I/O buffers, and air-conditioning is not required.

Unique system advantages include special instruction for individual requirements without any modification of the computer, and ease of addition of a wide variety of peripheral equipment without computer modification.

FUTURE PLANS

Continued development of I/O equipment.

INSTALLATIONS

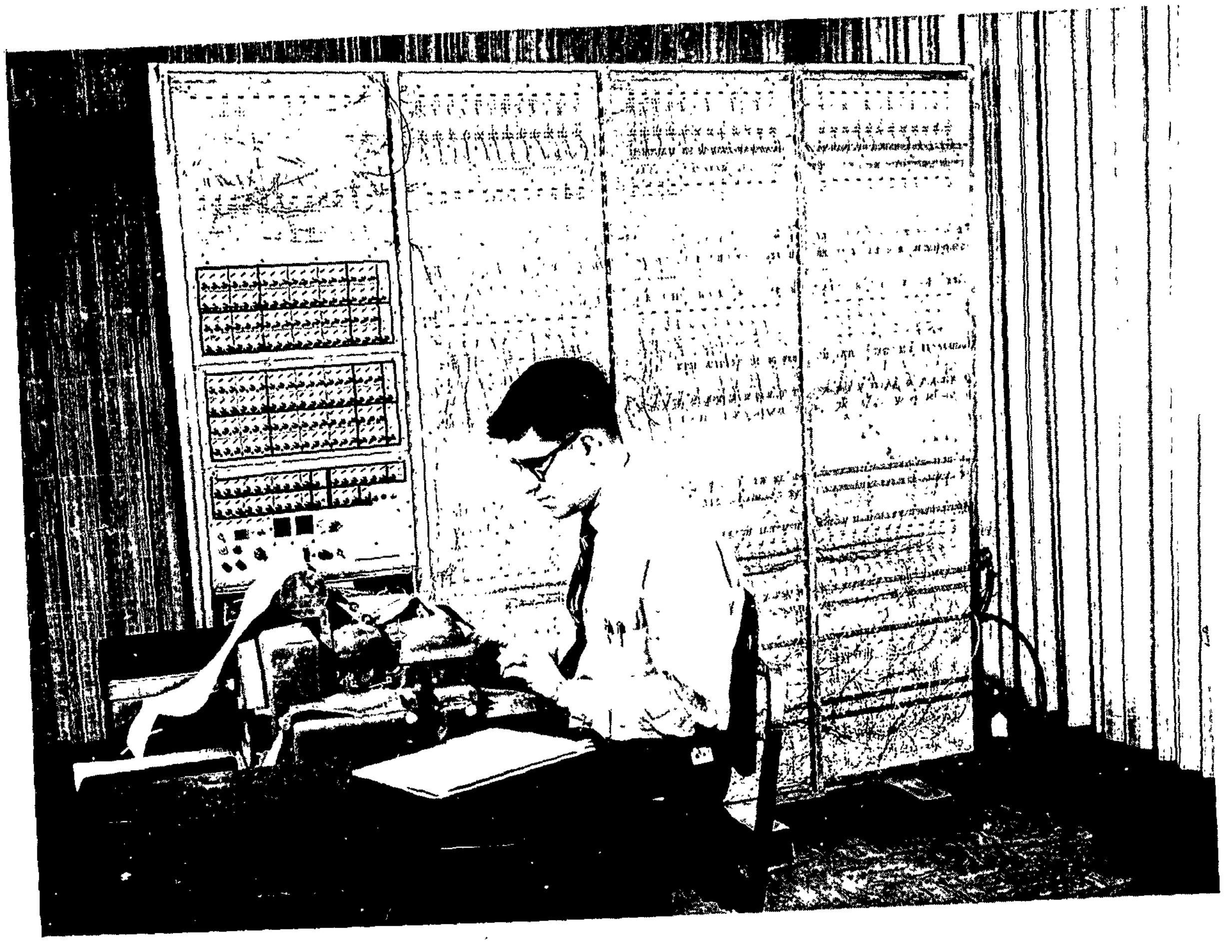
General Mills
Mechanical Division
2003 East Hennepin Avenue
Minneapolis 13, Minnesota

GENERAL MILLS APSAC

General Mills APSAC Computer

MANUFACTURER

General Mills
Mechanical Division



Dust Covers Removed

Photo by General Mills

APPLICATIONS

General purpose computer used in on-line automatic survey system.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	35 (plus sign)
Binary digits/instruction	18
Instructions per word	2
Instructions decoded	29
Arithmetic system	Fixed point
Instruction type	One address
Number range	2^{-35} to 2^{+35}

Instruction word format 36 bits

6	12	3	6	12	3
Oper	Address		Oper	Address	

Explanation of last three bits in each instruction

Address A Reg.	Clear A Register	Breakpoint

First two bits in this group are not used by every instruction.

Registers include an accumulator register (A) and a remainder register (R).

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	120	120
Mult	1,520	1,500
Div	16,200	Done by sub routine

Construction (Arithmetic unit only)

Transistors	Approx 1,200
Condenser-Diodes	Approx 16,000
Magnetic Cores	Approx 20,000
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	512	35 + sign	10

Magnetic Tape

No. of units that can be connected	2 Units
No. of chars/linear inch	48 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.667 Inches
Tape speed	25 Inches/sec
Transfer rate	1,200 Chars/sec
Start time	3 Millisec
Stop time	3 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	approx 300 Feet
Composition	Mylar

INPUT

Medium	Speed
Flexowriter	10 chars/sec

OUTPUT

Medium	Speed
Flexowriter	10 chars/sec

Typewriter and punch

System has, in addition to Flexowriter and magnetic tape, real-time input from digital clock and from astrolabe.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	20,000
Transistors	1,500
Magnetic Cores	20,000

CHECKING FEATURES

Magnetic tape has parity check across tape, and markers for usable and non-usable tape. Paper tape also has parity check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.86 Kw	0.96 KVA	0.9 pf
Volume, computer		52 cu ft	
Area, computer		15 sq ft	
Floor loading		35 lbs/sq ft	
		35 lbs concen max	
Weight, computer		520 lbs	

No special site preparation or air conditioner needed.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	Now in field test
Number on order	Now in field test
Time required for delivery	6 months

PERSONNEL REQUIREMENTS

Operator, programming, and maintenance courses are optional. Ordinarily GMI trains maintenance personnel, although it can be handled on contract basis if desired.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Both computer and magnetic tape equipment designed to operate under field conditions. Average operating time between component failures is about 600 hours.

FUTURE PLANS

Anticipate repackaging to minimize space requirements.

INSTALLATIONS

General Mills Mechanical Division
1620 Central Avenue
Minneapolis 13, Minnesota

GEORGE

Argonne National Laboratory "GEORGE" Computer

MANUFACTURER

Argonne National Laboratory

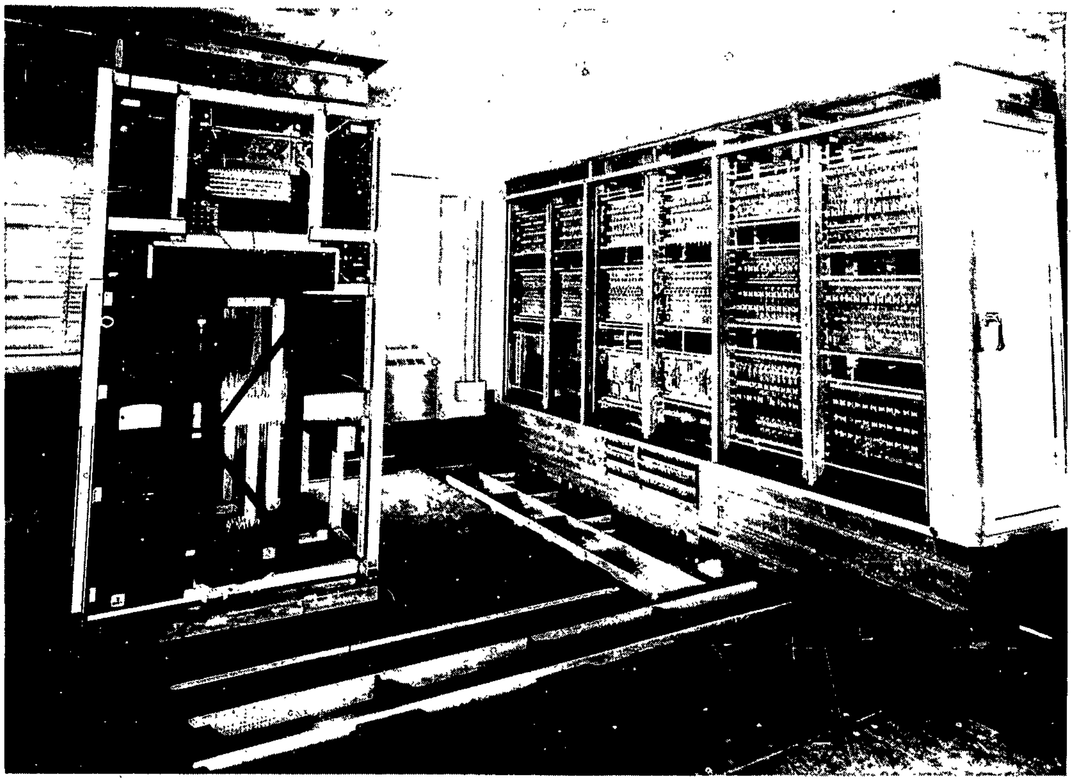


Photo by Argonne National Laboratory

APPLICATIONS

Scientific problems.
Data handling and data reduction.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system		Binary
Number of binary digits per word		40 or 80
Number of binary digits per instruction		20 to 100
Number of instructions per word		Variable
Total number of instructions decoded		2^{20}
Arithmetic system		
Floating Point		Fixed Point
Sign + 62 bit fraction	Sign + 39 bit fraction	
Sign + 10 bit power	20 bit positive integers	
6 bit index of significance		
Instruction type	Modified two-address for fixed point Variable zero through four-address for floating point	
Number range		
Fixed Point	$-1 < n \leqslant 1-2^{-39}$	
Floating Point	$[-1/2 \leqslant c \leqslant +1/2]$ $[2^{-1024} \leqslant \epsilon \leqslant 2^{+1024}]$	

Instruction word format

B-Address	Order	Tag	A-Address
0 - 11	12 - 19	20 - 27	28 39

Order	A-Address	B-Address	C-Address	D-Address
0 - 19	20 - 39	40 - 59	60 - 79	80 - 99

Automatic built-in subroutines
  Square root on floating point
Automatic coding
  GAR - George Assembly Routine (with Macro-instructions)
Registers and B-boxes
  Fixed and floating point arithmetic registers
  Four high speed floating point registers
  16 high speed index registers and any memory location
An index of significance is carried with each floating point number and is corrected with each operation as to the number of bits which are still significant.

Photo by Argonne National Laboratory

ARITHMETIC UNIT

Operation time, excluding storage access, Microseconds

	Fixed Point	Floating Point
Add	7	3
Mult	485	26
Div	595	27

Construction, arithmetic unit only	
Vacuum tubes	1,800
Transistors	20,000
Crystal diodes	6,000
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Concurrent

GEORGE is composed of two arithmetic units, a fixed point unit and a floating point unit. Each has its own word length and instruction code. The two arithmetic units work concurrently with a single memory.

STORAGE

Media	Number of Words	Number of Digits	Access Microseconds
Magnetic core	4,096	42 bits/word	7.5
Wide magnetic tape	4×10^6	42 bits/word	

Magnetic tape system features are:	
Maximum number of units that can be connected to the system	4 Units
Channels or tracks on the tape	42 Track/tape
Tape speed	43 Inches/sec
Physical properties of tape	
Width	2 Inches
Length of reel	1200 Feet
Composition	Mylar Sandwich

Tape has fixed blocks of 128 words. The time per block is 70 millisec: Including start, read or write, and stop. Tape may be searched for a particular block while the computer is computing.

INPUT

Media	Speed
Paper tape (2 readers)	1,000 alphanumeric char/sec
Narrow mag tape	15,000 alphanumeric char/sec
Keyboard	Manual

OUTPUT

Media	Speed
Paper tape	60 alphanumeric char/sec
Narrow mag tape	15,000 alphanumeric char/sec
Buffered 16 microsecond tieup for computer	
On-line printer	72 columns; 600 lines/minute
Buffered 28 microsecond tieup for computer	
Console typewriter	10 char/sec
Cathode ray tube	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	
Type	Quantity
5670	70% of 3,500
Diodes	
1N191	30% of 6,000
1N628	20% of 6,000
S55G	50% of 6,000
Transistors	
2N393	85% of 20,000
Magnetic cores	164,000

CHECKING FEATURES

Parity on Input, Output, and Core memory.
Complete redundancy and Dropout error.
Correction on wide magnetic tapes.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer 50 K.W.
Air conditioner part of building system.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

Floating point is under construction. Completion date is 31 December 1960. Fixed point has been in operation since September 1957.

PERSONNEL REQUIREMENTS

	Two 8-Hour Shifts
Supervisors	3
Analysts	3
Programmers	15
Clerks	2
Librarians	1
Operators	2
Engineers	1
Technicians	2
In-Output Oper	2

Description of the order structure and the programming systems available are found in ANL-5995, GEORGE Programming Manual by Loretta Kassel.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Fixed Point GEORGE has been operating two and 1/2 years with an average effective time over 80%. In the past year the effective time has been about 90%.

ADDITIONAL FEATURES AND REMARKS

Outstanding Features:

1. FLIP (Floating Point Unit) numbers have index of significance, i.e. an indication of how many significant bits remain in the number.
2. In fixed point (GEORGE) the first 12 bits of any memory location can be used as an index register. Thus, 4096 "index registers" are available.
3. In fixed point operations, GEORGE Instructions 2-nd address (B-address) has a variety of uses, it can be used as an index address, a "preliminary add" address, a store address, and/or a jump address.

Unique System Advantages:

1. Flexibility of B-address allows for compact coding - to make for better use of the 4096 word memory in fixed point operations.
2. Length of floating point word, and the index of significance, allow for more accuracy in floating point operations.

INSTALLATIONS

Argonne National Laboratory
9700 Cass Avenue
Argonne, Illinois

FUTURE PLANS

Present plans call for a 128,000 word drum and for a larger, faster core memory.

GEOTECH AUTOMATIC

MANUFACTURER

Geotechnical Automatic Chart Reader

The Geotechnical Corporation

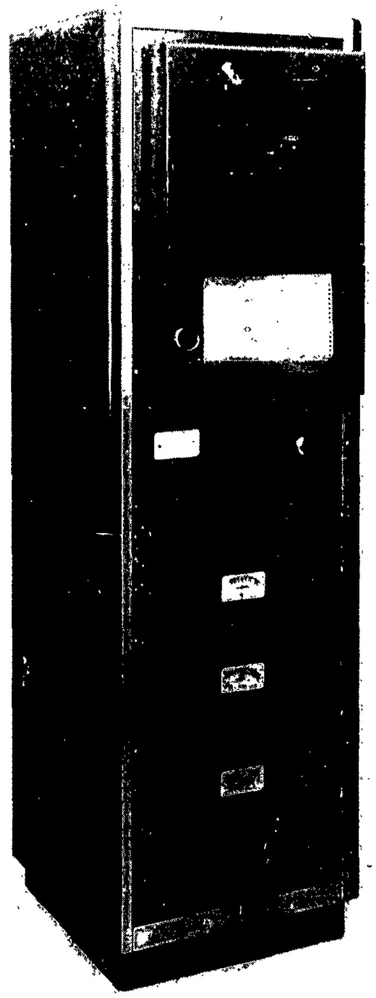


Photo by the Geotechnical Corporation

APPLICATIONS

System reads information contained on plotted charts, converts into several forms of output, and performs simultaneous computations, digital or analogue. The recorded charts are scanned optically, output is produced proportional to trace ordinate, and operations are performed on the output.

So many different sizes and configurations of charts and films are recorded by such a variety of techniques that no one instrument configuration could possibly be designed to read them all. However, the basic techniques, utilizing the BASIC READER, the CONVERSION UNITS, or the COMPUTING UNITS, can be applied successfully to many unusual types of charts and films. A drive system for the chart is often obtained by employing a drive similar to the one on which the chart was originally recorded. For best results, the trace on the chart should have good contrast with the chart paper. For example, a BASIC READER, with the digital computer, reads year-long river and stream water level charts, feeds the computer which computes daily mean discharge and water level, and reads out to punched tape, then automatic typewriters.

PROGRAMMING AND NUMERICAL SYSTEM

Computations are performed with modular computing units. Rack mounted computing units may be added in building block fashion. Computing units perform integration, multiplication, addition, subtraction, reciprocal, variable functions and others.

INPUT OUTPUT

The BASIC READER consists of an optical projection system, a scanning system, and electronic circuitry. It is located so that a thin strip of light, focused on the chart at right angles to the long axis of the chart, reflects a narrow cross-sectional image of the chart onto a rotating scan disk. The dark trace of the chart does not reflect light; however, the white paper background on either side of the trace does reflect. Therefore, the strip of light imaged on the scan disk appears to be broken by a dark "spot." When the drive is turned on and the chart is set into motion, this spot undulates back and forth across the surface of the disk exactly as the trace undulates on the chart. The rotating scan disk is made of glass with an opaque coating through which two or more transparent slits have been scribed. These scribed slits are usually in the form of involute curves because a rotating involute provides a linear sweep and always intersects the strip of light from the chart at right angles. The type and number of slits scribed on the scan disk, as well as the rotational speed of the disk itself may vary according to particular requirements, however a speed of 3600 RPM and two involutes are common. As the disk rotates and its involute slit first intersects the strip of light imaged on it, light is allowed to pass through the slit to strike a photomultiplier tube. As rotation continues, the involute next intersects the dark spot, i.e. the reflected trace, and light to the photomultiplier is momemtarily cut off, generating a pulse. A reference trace on the chart or reference marks on the disk are often used to generate another pulse which defines the base of the chart. A gating circuit then forms a measuring pulse whose duration is proportional to the spacing of these two pulses, and therefore proportional to the ordinate of the recorded trace. By rotating the disk containing the two slits at 3600 RPM, the location of the ordinate of the trace is pin-pointed 7200 times a minute. This system provides a continuous or periodic pulse-width output proportional to the trace ordinate of the moving chart, accurate to ± .1% of full scale, and this output is all that is required for many purposes, however, additional outputs are available with modular conversion units. By adding optional rack-mounted conversion units in building-block fashion, the basic pulse-width output may be converted to digital, analog voltage or current, or mechanical rotation or displacement.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1 Kw
Volume, computer	16 cu ft
Weight, computer	300 lbs

COST, PRICE AND RENTAL RATES

$10,000 for analog
$20,000 for digital
Maintenance contract is available

PERSONNEL REQUIREMENTS

One operating technician is required. He can be taught on-the-job.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Good time	150 Hours/Week (Average)
Attempted to run time	180 Hours/Week (Average)

ADDITIONAL FEATURES AND REMARKS

	SPECIFICATIONS
Chart Drive	Synchronous motor
Chart Speed	12" per minute. Others available upon request.
Scan Rate	120 scans per second. Approximately 600 scans and PWM pulses per linear inch of chart at speed of 12" per minute.
Accuracy	PWM pulses proportional to trace ordinate are accurate to within ± 0.1% of full scale. Analog voltage output proportional to trace ordinate is accurate to within ± 1% of full scale.
Output	This model: 1 MA into 40 K ohms, designed to match a TI recti/riter recorder.
Power Requirements	500 VA, 115 volts, 60 cps.
Dimensions	24" deep; 24" wide; 50 1/2" high.
Weight	250 lbs (115 kg.)
Chart Requirements	This model is designed to read 6" rectilinear, single-trace charts.
Extraneous Marks	Charts must be free from marks that will produce spurious signals.
Trace	Continuous black line at least .020" wide.
Trace Contrast	Trace should have good contrast with chart paper.
Grid Lines	Preferably none; watery-green grid lines acceptable.

HAMPSHIRE CCC 500

Coordinate Conversion Computer Model 500

MANUFACTURER

Hampshire Engineering Company

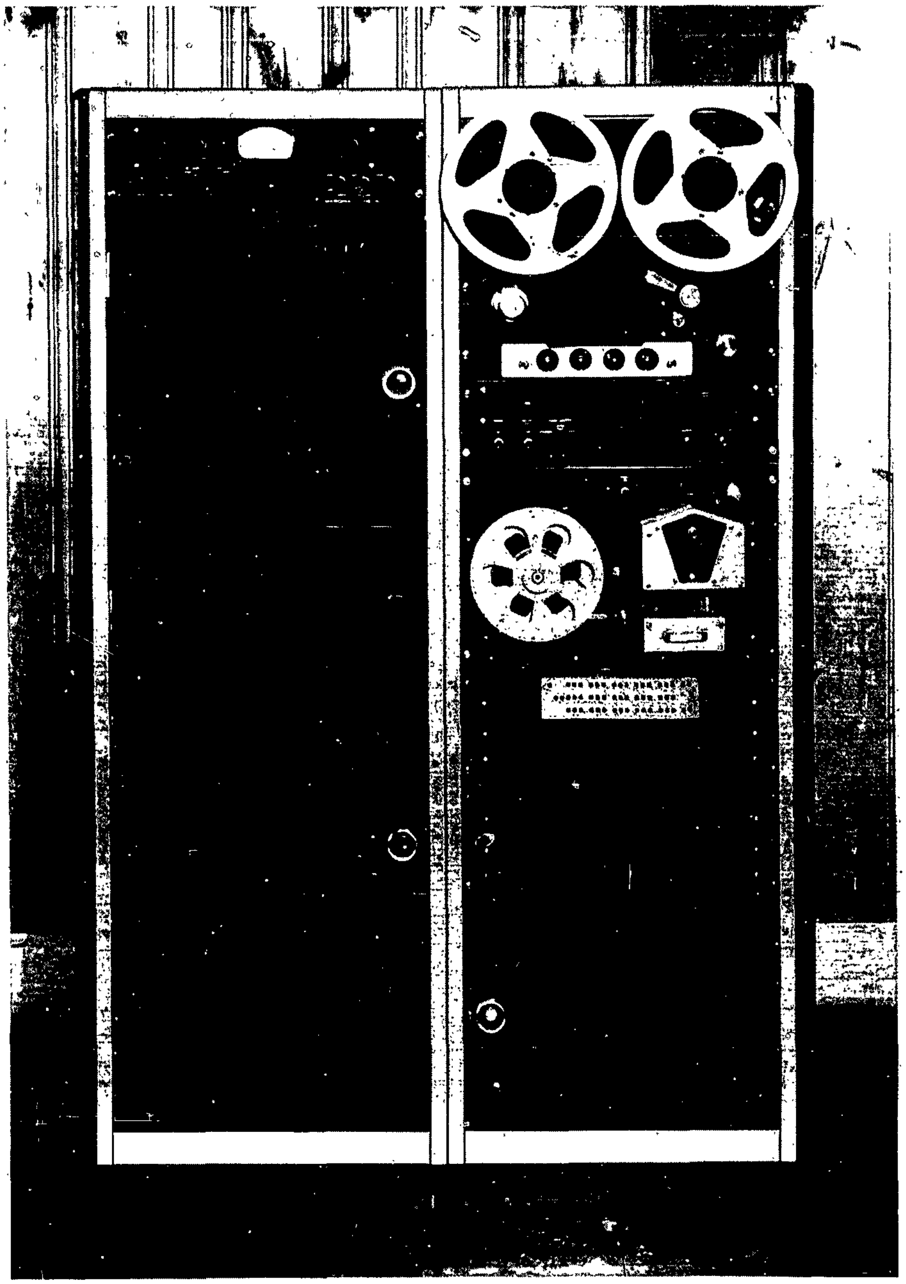


Photo by Hampshire Engineering Company

APPLICATIONS

Computer is used with automatic tracking theodolites to give real time display and rapid tabulation of aircraft position in rectangular coordinates.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20
Arithmetic system	Fixed point
Instruction type	Wired program
Number range	Fractional

Automatic built-in subroutines include translation of binary to binary coded decimal excess 3.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	428	428
Mult	8500	8500
Div	8000	8000

Construction (Arithmetic unit only)
Vacuum-tubes, magnetic cores, and diodes

Arithmetic mode	Serial
Timing	Synchronous
Operation	Concurrent

Arithmetic functions are performed concurrently by several small units connected directly with magnetic storage registers. Diode logic and vacuum tube amplifiers are used.

STORAGE

Medium	No. of Words	No. of Digits
Core-Diode Shift Registers	9	22

Magnetic tape used for output only.

INPUT

Input is by cable connection to shift registers in theodolites, and is in the form of binary coded pulse trains.

OUTPUT

Media	Speed
Analogue Voltages for X, Y, Z Used by plotting board	Real time
Punched tape Feeds ELECOM 120 Computer or Flexowriter	60 char/sec
Magnetic tape X, Y, Z in serial form. X, Y, and Z refer to rectangular coordinates.	2 & 4 in/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	
Tubes	98	in computer
	66	in output units
Diodes	Approx 1,000	
Magnetic Cores		
SR-100	450	

CHECKING FEATURES

Checking features include built-in marginal checking and built-in test problem input and output monitor.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1.0 Kw
Volume, computer	38 cu ft
Area, computer	7 sq ft
Room size	Any room

No special site preparation requirements.

PRODUCTION RECORD

Number produced to date	1
Time required for delivery	6 months

COST, PRICE AND RENTAL RATES

Computer only	Approx $50,000
Computer with output equipment	Approx $80,000

PERSONNEL REQUIREMENTS

No special operators needed. Equipment can be operated by one man after a few hours' checkout. Service easily handled on part-time basis by one engineer or senior technician.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Simplicity is obtained by semi-permanently wiring computer to perform a specific problem solution.

Magnetic core storage driving diode logic directly reduces active elements and increases reliability. Dynamic pulse techniques used.

Total failures to date consists of 4 diodes, 1 resistor, and 3 printed circuit board connections. This covers a period of 3 years.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include speed ample for real-time uses, computer is very simple with high reliability, and is unusually accurate in analogue output.

FUTURE PLANS

This system is being superseded by Model 932 Computer, which is faster, is more flexible, has greater capacity, and uses transistors rather than tubes.

HAMPSHIRE TRTDS 932

Hampshire Theodolite Real Time Display System
Model 932

MANUFACTURER

Hampshire Engineering Company

APPLICATIONS

The real time computer and display system is used with Contraves Phototheodolites to produce precision plots and tabulation of aircraft position in rectangular coordinates. It can also be used for radar coordinate conversion and other real time problems with appropriate problem changes.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	22
Binary digits/instruction	Wired problem
Arithmetic system	Fixed point
Instruction type	Wired problem
Number range	22 bits (Fractional, incl. sign)

Automatic built-in subroutines include sine, cosine, tangent and translation of binary to binary coded decimal.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	220	220
Mult	1760	1760
Div	5300	5300

Construction (Arithmetic unit only)

Transistors	85
Magnetic Cores	165 Core-transistor shift registers
Arithmetic mode	Serial
Timing	Synchronous
Operation	Concurrent

STORAGE

Medium	No. of Words	No. of Dig/Word
Core-Transistor Shift Register	15-easily expanded	22

INPUT

Media	Speed
Magnetic Tape	Real time
Telephone Lines	Real time

Telephone lines connect to the theodolites.

OUTPUT

Media	Speed
30" x 30" Plotting Board	Real time
Magnetic Tape	Real time
Punched Tape	1/3 real time
Flexowriter	1/10 real time
Analogue Voltages for X, Y, Z	Real time

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Use
Tubes	65	Output units
Diodes	3,000	
Transistors	500	Computer
	400	Auxiliary equipment
Magnetic Cores	650	Computer
	450	Auxiliary equipment

All figures are approximate. The computer cores are in the core-transistor shift register.

CHECKING FEATURES

Checking features include built-in marginal checking, built-in test probleminputs and output monitor, and parity check on data transmission.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer 1.5 Kw, approx
Power includes auxiliary equipment.

PRODUCTION RECORD

Number in current production	1
Number on order	1
Time required for delivery	Approx 6 months

COST, PRICE AND RENTAL RATES

Computer	$50,000 to $100,000
Complete system	$100,000 to $250,000

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Operators	1	2	3
Engineers	1/4	1/4	1/2
Technicians	1/2	1	1

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Simplicity is obtained by semi-permanently wiring computer to handle a specific problem. Extremely conservative design is used. Magnetic cores are used for storage. Cores drive diode logic directly, thereby reducing number of active elements. A modified dynamic pulse technique with magnetic cores is used.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include ample speed for real time use, simplicity with high reliability, operability by personnel with minimum training and unusual accuracy in analogue output.

INSTALLATIONS

Hampshire Engineering Company
2300 Washington Street
Newton Lower Falls 62, Mass.

HONEYWELL 290

Honeywell Computer Model 290

MANUFACTURER

Minneapolis-Honeywell Regulator Company
Special Systems Division

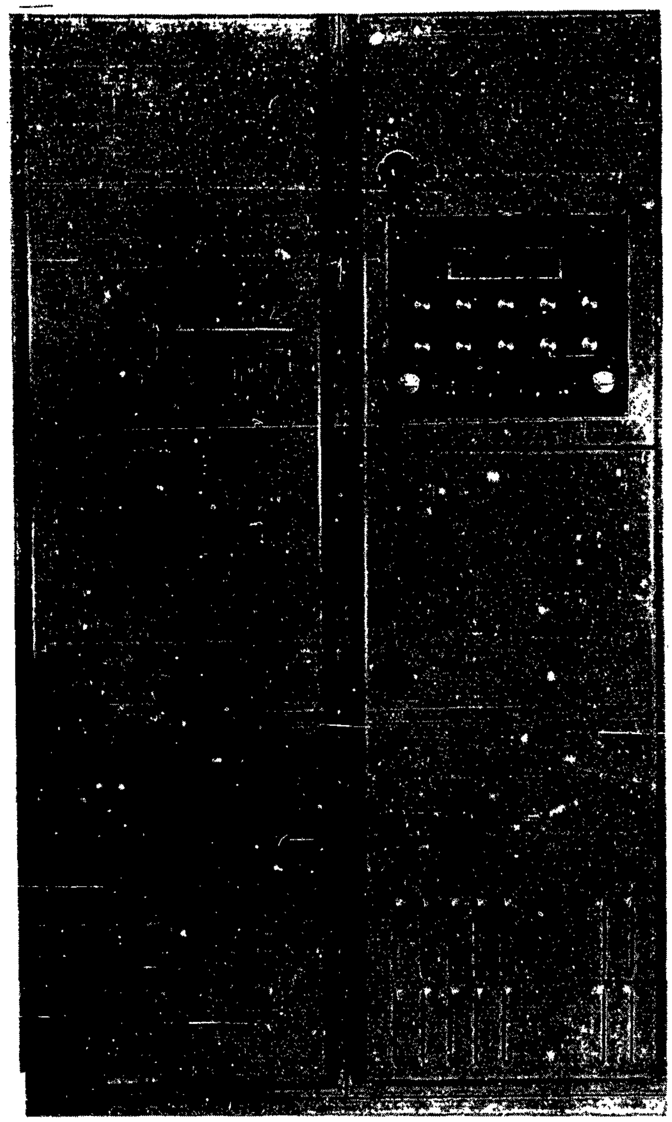
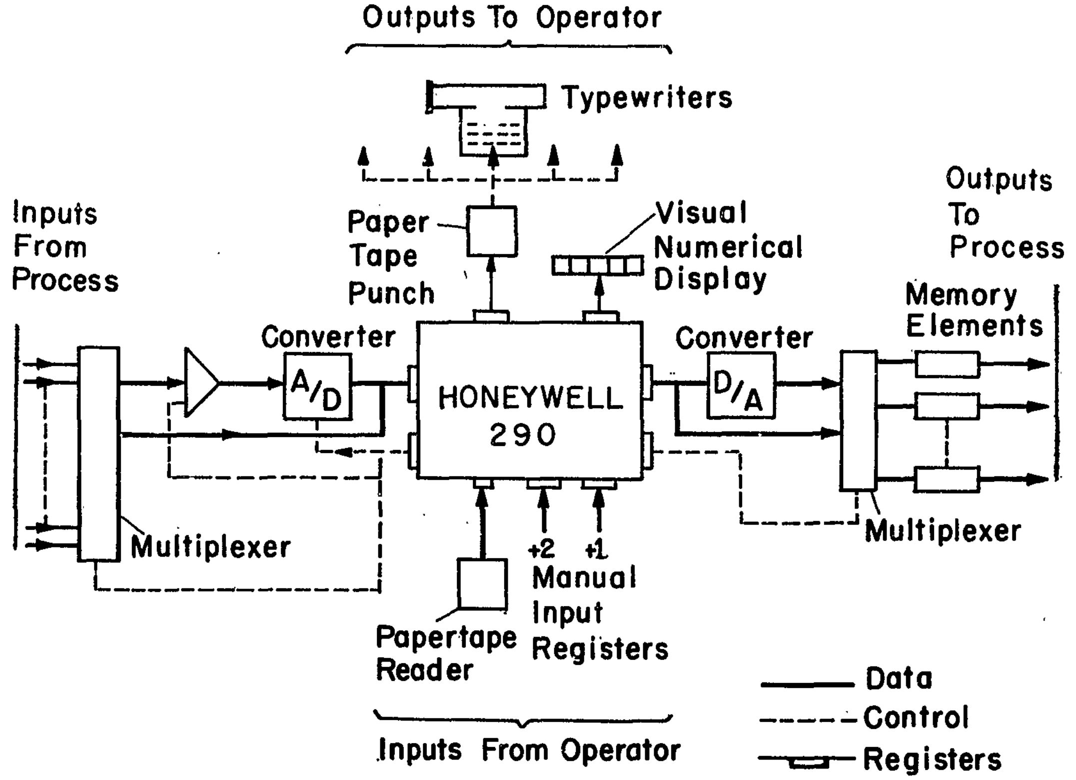


Photo by Minneapolis-Honeywell Regulator Company

APPLICATIONS

The Honeywell 290 Computer is a general purpose, internally stored program digital computer especially designed for use as a highly reliable on-line computer for process or operation monitoring and-or control. The H290 features all solid state circuitry, high speed, low clock rate, both core and drum memory, concurrent input, output and compute operation. The H290 can be furnished with over 70 instructions selectable by the user from a list of over 150 available instructions. The H290 Computer with associated peripheral equipment can accept over 4,000 inputs at scanning speeds up to 1,000 points per second, perform calculations in real-time and produce over 4,000 outputs.



HONEYWELL INDUSTRIAL DIGITAL COMPUTER CONTROL SYSTEM DIAGRAM

Diagram by Minneapolis-Honeywell Regulator Company

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary or Bin. Coded Dec.
Binary digits/word	18 Binary or 4 1/2 decimal
Binary digits/instruction	18 Binary
Instructions per word	One
Instructions decoded	Variable - any 70 or so out of over 150
Arithmetic system	Floating point

Can be provided as single instructions
Fixed point
Fractional (2's complement arithmetic)

Instruction type	One address

6 bit operation code and 12 bit address. Several complex orders use two words as a single order.

Number range	0 to 262, 143 in Binary and 0 to 39,999 in Binary-Coded- Decimal

Instruction word format

6 bits		12 bits	
Operation Code		Address	
18	13	12	1

There is no need for "built-in" subroutines. A group of 80 micro-instructions are assembled into macro macro-instructions dependent upon the Control Section logic. These macro-instructions may be changed with comparative ease. A Control Section will be supplied according to the application and the user's desires and it can be modified or changed if the need arises.

Assembly routines are provided.

The H290 utilizes over 26 registers. Three are for inputs, 5 for outputs, 1 for instruction sequence, 4 for arithmetic and the balance for other internal computer functions. The entire core memory could be utilized as index registers.

The basic operation code consists of 6 bits, 64 orders involving memory addresses. A "no-address" type of order allows for 64 additional orders not involving variable addresses. If additional orders involving memory are required, the Control Section may be easily modified to utilize a "no-address" order as one addressing memory. The Control Section by being mostly magnetic, can have its entire order structure completely altered if desired. Because it is not conceivable that any one application would have need of the complete possible instruction vocabulary, it can be said that the number of available instructions is limitless for a particular application.

ARITHMETIC UNIT

Operation	Incl Stor Access to both Operands & "Housekeeping" Microsec	Incl Stor Access to One Operand & "Housekeeping" Microsec	No Access to Operands and No "Housekeeping" Microsec
Add	200	140	100
Mult	860	800	760
Div	1420	1360	1320

"Housekeeping" consists of those portions of each order that are identical for all orders and it accounts for 40 microseconds.

Construction (Arithmetic unit only)
 Transistors 500 approx.
 Diodes 1,500 approx.
Arithmetic mode Parallel
 2's complement arithmetic is used throughout which allows a powerful but comparatively simple add net work. No special logic is needed to handle sign determination. Arithmetic is completely binary with a relatively simple decimal translator for addition and subtraction. Binary-to-Decimal and Decimal-to-Binary conversion orders are provided for complete flexibility.
Timing Synchronous and Asynchronous
 The basic clock frequency of 50 kc is realized through use of an asynchronous logical clock of six unique time periods each of which is independently variable.
Operation Sequential and Concurrent
 Instructions are executed in sequence but input, output and internal computations are easily realized simultaneously. The computer itself is synchronized by the clock, but the clock is not an oscillator or multivibrator. A basic timing device and logic manipulator have been combined into the Primary Clock which can have no false moves. Separate Core Memory and Drum Memory Clocks are synchronized by the Primary Clock.

STORAGE

Media	No. of Words	No. of Digits (Max)	Access Microsec
Magnetic Core	1,024; 2,048; or 4,096	Binary 73,728 Decimal 16,384	20
Drum	4,096 or 8,192	Binary 147,456 Decimal 32,768	1700 Avg

 Drum capacity is expandable to 32,000 words. Drum successive locations will require only 128 microseconds up to a maximum of 252 words. The first word of a series will average 1700 microseconds.

INPUT

Media	Speed
On-line from Analog-to-Digital Converter or from Digital Inputs directly	Up to 10,000 18-bit char/sec

 For real-time on-line acquisition of process measurements.

Media	Speed
Manual Dials	Approx 60 microsec per setting of the dials

 For occasional entry of new fixed information or new instructions.

Media	Speed
Punched Paper Tape	20 char/sec

 Primarily for Program Loading.

OUTPUT

Media	Speed
On-line to Digital-to-Analog Converter or to Digital Devices	Up to 10,000 18-bit char/sec

 For real-time on-line control of process variables or for actuating alarms, on-off devices, etc.
Numerical Display Lights
 For decimal or hexadecimal notation of computer words.
Punched Paper Tape Up to 60 char/sec
 For subsequent feed to electric typewriters
On-line Digital Up to 10,000 18 bit char/sec
 Two paths for selection of Input and Output Channels.

By means of a unique order structure and proper programming, it is possible to interlace an input program, an output program and a computation program. The input program will initiate input commands to peripheral devices and then switch control to the computation program. The computation program will periodically check to see if the input device has completed its conversion. When complete, the input program may then call for the next input and then jump to the output program. An output command may then initiate action by an appropriate output device and then jump to the computation program. This may be considered as a form of "traffic control". Proper programming prevents a series of input and output commands from "backing up" and virtually eliminates any waiting time for peripheral devices. The order structure enables the checking of peripheral devices for the completion of their last task and upon completion another command is issued to the peripheral device and the program can then immediately branch to another routine, periodically checking for the completion of the latest command issued to the peripheral device. The manner in which this is achieved by the program is quite simplified and flexible. Input and output channels are selectable by the twelve address bits of the input or output instruction thereby enabling the selection of any one of 4,096 inputs or 4,096 outputs.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Approx Quantity
Diodes	9,000
Transistors	1,500
Magnetic Cores	75,000

CHECKING FEATURES

Due to the nature of the applications on which this computer is intended to be used there is no requirement for parity checks nor checking bits associated with any word. Programmed system self checks and input and output reasonableness checks can be easily incorporated into the complete program. Particular types of checking can be incorporated in the order structure as a part of the Control Section on special order at additional cost. Simple program checks and verifying diagnostic routines can easily be incorporated in the complete program.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer w/air cond	1.4 Kw	2.3 KVA	0.6 pf
Power, air conditioner	0.3 Kw	1.1 KVA	
Volume, comp w/air cond		56 cu ft	
Area, comp w/air cond		8 sq ft	
Room size		10 ft x 10 ft	
Floor loading		144 lbs/sq ft	

Load is uniformly distributed over rectangular 2 ft x 4 ft frame with 1 5/8 inch frame width.

Capacity, air conditioner 0.5 Tons

The H290 is designed for industrial use and therefore no extreme site preparation is required. The air conditioner is built in.

PRODUCTION RECORD

Time required for delivery from receipt of order 12 to 18 months.

COST, PRICE AND RENTAL RATES

For 1 Honeywell 290 Computer with 4,096 words of core memory and 8,192 words of drum memory, 1 Paper Tape Reader, and 1 Paper Tape Punch, the selling price is approx. $170,000.

Electric typewriters or printers, analog-to-digital converter, digital-to-analog converter, multiplexers, operator console(s), and control amplifiers are available. The selling price of total system, including additional equipment, varies, depending upon the application requirements. Various leasing and maintenance arrangements are available.

PERSONNEL REQUIREMENTS

Maintenance, programming and operator training are provided according to the purchaser's requirement.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The H290 Computer has been designed for maximum reliability and 100% availability for continuous operation. The "mean time between failures" is well over a thousand hours of continuous operation. Wire-wrap and jet soldering techniques have been used throughout. Individual package construction utilizes ladder type arrangement of components. The number of components per package greatly reduces the usual number of mechanical connections; and floating connections are used throughout. Circuit parameters have been derated better than 50%. Computer operation is such that complete protection is provided for the prevention of the stored program or constants from being inadvertently destroyed by the operator or an external disturbance.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include high performance and speed, high reliability, protected program storage, flexible instruction vocabulary, use of both core and drum memory, and ease of programming and maintenance. Single instructions can be provided for complex sub-routines without requiring more than one reference to memory.

Unique system advantages include random selection of inputs and outputs in accordance with the program, concurrent input, output and compute operation, and up to 1,000 points per second input selection speed.

The Honeywell Computer Control System utilizing the H290 Computer is applicable for all types of industrial, commercial and military process or operation monitoring and control. Complete application assistance can be provided extending from economical and technical feasibility study through installation and maintenance of the system. All process transmitters, transducers and peripheral equipment can be provided by HONEYWELL.

Concurrent Operation

Execution of internal computations, concurrent with operation of almost any number of peripheral devices (such as paper tape reader, a tape punch, a typewriter, an analog-to-digital converter, etc.) is possible due to the internal logic and random access core memory of the computer. This feature effectively permits the attention of the computer to be devoted to continuous process control of the particular process and to the calculation of process formulae.

For instance, the computer program can randomly select an input channel. If this input channel represents a process variable such as a temperature (read by a thermocouple), its value is usually in analog form (continuous signal) and must be converted to digital form (discrete digits) for presentation to the computer. Conversions of this sort are handled by the computer peripheral equipment; in this case, the analog-to-digital converter. While the computer peripheral equipment carries out this conversion, the computer itself is free to perform other operations. Between operations, the computer "looks at" its input registers to see if the conversion is completed. When the peripheral equipment has completed the requested conversion, the computer is signaled and will accept the digitized value.

The same principle applies to all peripheral operations. All of these can occur concurrently.

Transistorized for Reliability

The Honeywell 290 has solid state components throughout all electronic circuits and is designed to operate in an industrial environment with a minimum of maintenance. Reliability is further assured not only by the low clock rate but also by operating the transistors and diodes far below the maximum levels recommended by the component manufacturers. This lengthens component life. In addition, the Honeywell 290 contains a cooling unit to substantially lower the internal temperature in the computer proper to further increase component life.

HONEYWELL 800

Honeywell 800

MANUFACTURER

Minneapolis Honeywell Regulator Company
Datamatic Division
Newton 61, Massachusetts

Photo by Minneapolis Honeywell Regulator Company

APPLICATIONS

Designed for general purpose business, business-scientific, and scientific applications, system capable of running eight programs simultaneously.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary and binary-coded decimal
Number of binary digits/word	48
Number of decimal digits/word	12 plus checking
Number of binary digits/instruction	48
Number of decimal digits/instruction	12 plus checking
Number of instructions/word	1
Number of instructions decoded	59 basic types
Arithmetic system	Floating point (optional) Fixed point (standard)
Instruction type	Three address
Number range	
Decimal $n_d \cdot 10^{e_d}$	$-64 \leq e_d \leq 63$ $-(1-10^{-10}) \leq n_d \leq (1-10^{-10})$
Binary $n_b \cdot 2^{e_b}$	$-64 \leq e_b \leq 63$ $-(1-2^{-39}) \leq n_b \leq (1-2^{-39})$

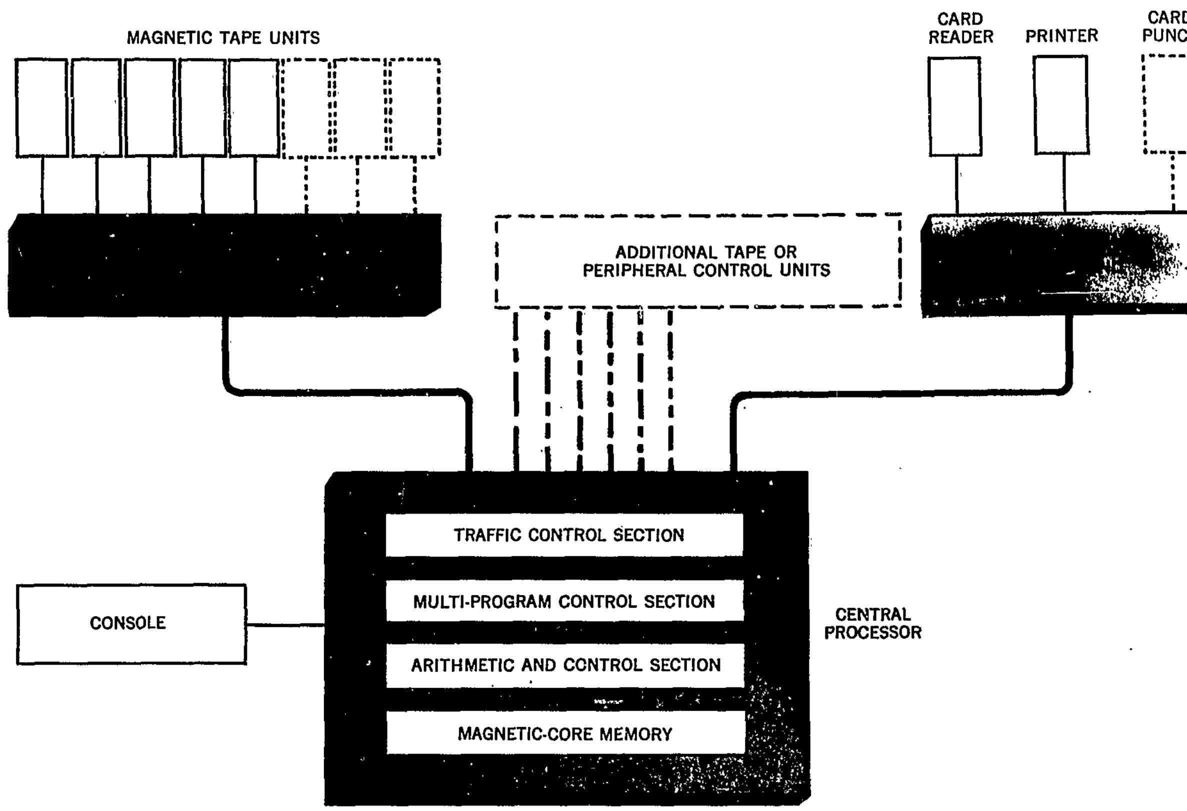


Diagram by Minneapolis-Honeywell Regulator Company

Instruction and information word format

Word Structure - The Honeywell 800 word consists of 54 bits, of which six are used for checking. The 48 information bits may represent an 11-decimal-digit number with its sign, several smaller decimal numbers, with signs for each, eight alphabetic characters, or a combination of these. A word may also be interpreted as a 44-bit binary number with its sign, or as an instruction. Using the floating-point option, a word may represent a sign bit, a seven-bit exponent, and a 40-bit mantissa in binary form.

HONEYWELL 800 WORD STRUCTURE

Type	Example											
Numeric	±	1	2	3	4	5	6	7	8	9	0	1
Alphanumeric	R	O	B	I	N	S	O	N				
Alphanumeric Compressed	C	.	W	E	B	B	1	7	4			
Binary	±	(44 Binary Digits)										
Instruction	Operation Code	Address A	Address B	Address C								
Floating Point	±	Exponent (7 Binary Digits)	Mantissa (40 Binary Digits)									

Instructions - In the instruction word, the information bits are divided logically into four sections which are interpreted as an operation code followed by three addresses.

Instruction Word

Operation Code	Address A	Address B	Address C
12 bits	12 bits	12 bits	12 bits

Indexing - Each address in an instruction may be designated as absolute or indexed. A total of eight index registers are available to each program.

Masking - The ability to mask words allows most internal processing instructions in the Honeywell 800 to work with fields of variable length. Each program may designate a group of 32 memory locations as masking registers. Such a designation may be changed by the programmer at any point in his program. Thus, an essentially unlimited number of masking registers is at his disposal.

Automatic built-in subroutines
- Exponential Overflow
- Exponential Underflow
- Division over Capacity
- Addition or Subtraction Overflow
- Read or Write Error
- Begin or End of Tape
- Parity Failure

Automatic coding
- Argus (Automatic Routine Generating and Updating System)
- Fact (Fully Automatic Compiling Technique)
- Algebraic Compiler
- Library of Subroutines
- Executive Routine

Registers and B-boxes
- 64 Index Registers
- 8 Mask Index Registers
- 32 Input-Output Control
- 32 Sequencing and History
- 96 Special (Programmer's Usage)
- 8 Automatic Subroutines
- 16 Internal Control
  - Accumulator Register
  - Low Order Product-Quotient Register
  - Mask Constant Storage Register
  - Program Control Register
  - Machine Control Register

ARITHMETIC UNIT

	Incl. Stor. Access Microsec.
Add time	24
Mult time	162
Div time	450

Construction, arithmetic unit only	
Vacuum tubes	None
Transistors	2,000
Condenser-Diodes	10,000 diodes
Arithmetic mode	Parallel-Serial-Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Ferrite Cores	Up to 32,000	Up to 384,000	2.1

Magnetic Tape

No. of units that can be connected	64 Units
No. of chars per linear inch	533 Chars/inch
No. of decimal digits per linear in.	800 dd/inch
Channels or tracks on the tape	10 Tracks/tape
Blank tape separating each record	0.66 Inches
Tape speed	120 Inches/sec
Transfer rate	64,000 Chars/sec
Decimal digit transfer rate	96,000 dd/sec
Start time	3.5 Millisec
Stop time	3.5 Millisec
Average time for experienced operator to change reel	30 Seconds
Physical properties of tape	
Width	3/4 Inches
Length of reel	2,400 Feet + leaders
Composition	1.5 mil mylar

INPUT

Media	Speed
Punched Cards	240 cards/min
	650 cards/min
Paper Tape	200 chars/sec
	1,000 chars/sec

OUTPUT

Media	Speed
Punched Cards	100 cards/min
	250 cards/min
Printer	150 lines/min
	900 lines/min
Paper Tape	60 chars/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	30,000
Transistors	6,000

Above excludes peripheral equipment

CHECKING FEATURES

Verification of all data transmission, arithmetic processes, address modification, memory selections, and central processing. Orthotronic correction of tape data and marginal checking for preventive maintenance.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	32 Kw	57 KVA	0.80 pf
Capacity, air conditioner	9.11 Tons		
Weight, computer	15,720 lbs		

Requirements for the physical installation of a typical system are approximately as follows:

Data Processing Area	1,200 square feet
Service Engineering Area (including parts storage)	400 square feet
Ceiling Height	8 feet
Floor Load Capacity	75 lbs/square feet (max)

It is recommended that a raised floor be installed over the existing base floor for the protection of interconnecting cables. This floor should be a free-access type, 9 inches high with a minimum of 5 1/2 inches clearance underneath for accomodating cables.

PRODUCTION RECORD

Deliveries start in December 1960.

COST, PRICE AND RENTAL RATES

Figures given are for a typical system.

Basic system, including a Central Processor, 4,096 words of memory, High-Speed Printer Type Control, High-Speed Card Reader, Six Magnetic Tape Units, High Speed Card Punch, Printer-Card, Reader-Card Punch Control.

Purchase price	$975,000
Floating-point option	101,800
Additional memory blocks (4,096 words/block)	153,600
Rental, basic system above, monthly	20,665
Rental, floating point option, monthly	2,100
Rental, additional memory blocks	3,200

Maintenance service contract available.

PERSONNEL REQUIREMENTS

Personnel requirements depend on equipment configuration and application. Complete training courses for programming and operating staff included with purchase and rental charge.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Each unit and entire system incorporate fail-safe checking. Special construction techniques minimize cold-solder joints and intermittent contacts. All units are designed for simplicity of maintenance and speed of replacement of parts.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include parallel processing, traffic control, system modularity, outstanding system reliability, open-ended design, automatic programming aids (FACT, ARGUS, Algebraic compiler).

Unique system advantages include ability to run up to 8 programs simultaneously without any special programming or special instructions.

Special procedures for magnetic tape labelling, storing, shipping, and protection from humidity, temperature, electrical, fire, or other damage are that relative humidity in area should be held at approximately 40% to insure maximum tape life, dry bulb temperature shall not exceed 74°F, and wet bulb temperature shall not exceed 59°F.

INSTALLATIONS

Army Map Service
6500 Brooks Lane
Washington 25, D. C.

Ames Research Center
Moffett Field, California (Anticipated)

AVCO Corporation
Crosley Division
1329 Arlington Street
Cincinnati 29, Ohio (Proposed)

HRB SINGER

Haller Raymond and Brown - Singer Electronic Memory Computer

MANUFACTURER

Singer Manufacturing Company
HRB-Singer, Incorporated, Subsidiary
Science Park, State College, Pennsylvania

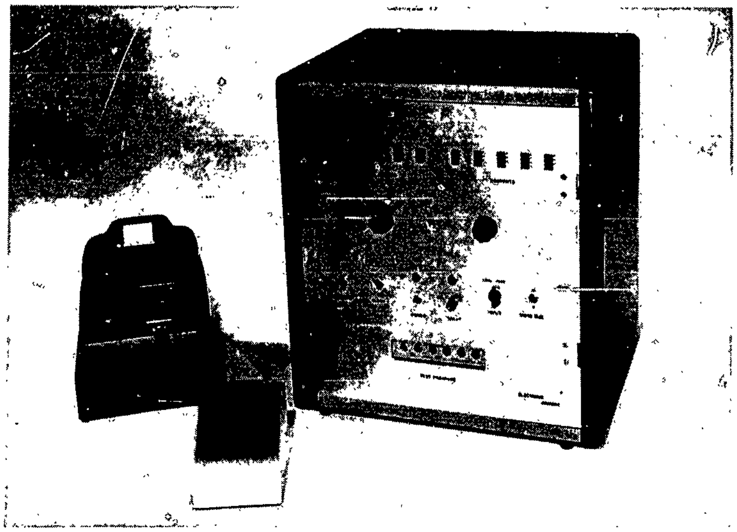


Photo by HRB - Singer

APPLICATIONS

It will accept numerical information for storage from either a push button or telephone input. It will readout on tape, punch tape or cards or vocally. Confirmation of instructions is obtained so corrections can be made prior to telling the machine to proceed.

STORAGE

Medium	No. of Words	Access Microsec
Magnetic Drum	1,024	5,000

16 binary digits per word

INPUT

Media	Speed
Telephone	regular dial telephone
Ten-key Push Button	

Telephone can be located any place. Vocal confirmation is given.

OUTPUT

Medium	Speed
Paper Tape	1 line/second

Regular adding machine output

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.01 Kw
Volume, computer	5 cu ft
Area, computer	2.25 sq ft
Weight, computer	85 lbs

Nothing is required in the way of site preparation.

PRODUCTION RECORD

Number produced to date	Several
Number in current production	Several

COST, PRICE AND RENTAL RATES

Price of basic system, including telephone and push button input, printed paper tape output and computer	$15,000
Additional 1,024 word storage drum	4,000
Monthly rental rate for basic system	400

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Attempted to run time 167 Hours/Week (Average)
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include low cost solution to critical inventory problems.

INSTALLATIONS

HRB - Singer, Inc.
State College, Pa.

HUGHES ADV AIRBORNE III

Hughes Advanced Airborne Computer Model III

MANUFACTURER

Hughes Aircraft Company

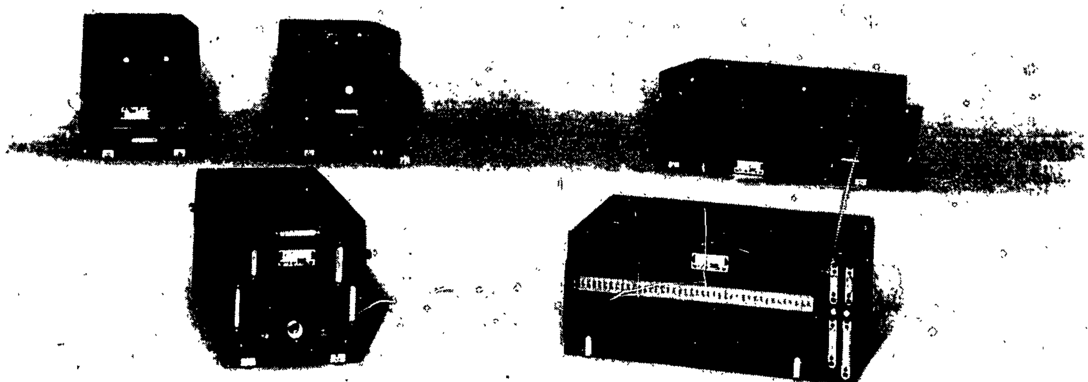


Photo by Hughes Aircraft Company

APPLICATIONS

Control of aircraft and aircraft equipment. In the specific application for which the computer was built, it performs navigation, flight control, and weapons control, receiving target and flight data as inputs and generating flight and weapons control signals as outputs. The system was developed for the U. S. Air Force for automatic control use in high speed aircraft.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	17
Binary digits/instruction	17
Binary digits/instruction not decoded	2
Instructions per word	1
Arithmetic system	Fixed point
Instruction type	Modified two address

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add time	200
Mult time	1,700
Div time	1,700
Construction	Vacuum tubes
Rapid access word registers	3
Basic pulse repetition rate	162 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous with magnetic drum
Operation	Sequential

STORAGE

Media	Words	Access Microsec
Magnetic Drum	1,984	3,750 average
Magnetic Drum	8	400 average

Total capacity is 37,648 binary digits.
All programs are coded for minimal latency.

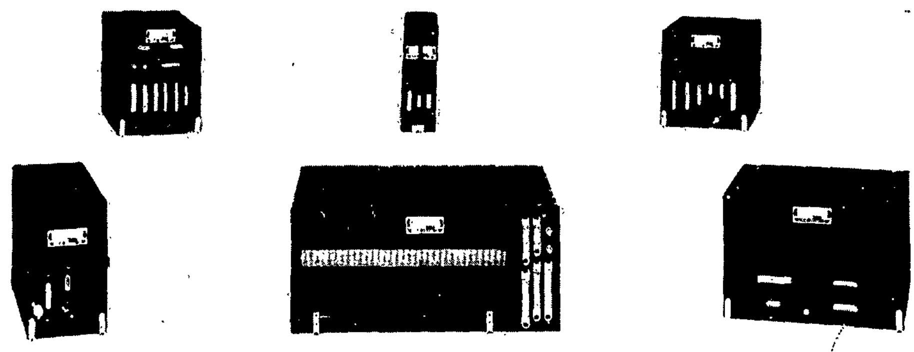


Photo by Hughes Aircraft Company

INPUT

Medium	Speed	
Analog D. C. Voltage	200 microsec	0-100V D. C.

Other analog inputs are available. This is used as a control computer with analog inputs and outputs; however, paper tape is used as an additional input medium.

OUTPUT

Medium	
Analog D. C. Voltage	0-100V D. C.

Other analog outputs are available. Magnetic tape ultimately feeding a Flexowriter is used as an auxiliary output.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	481
Crystal diodes	3,364

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1.5 Kw
Volume, computer	5 cu ft

The arithmetic and control unit of the computer occupies approximately 0.6 cu ft and weighs 20 lbs.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Ratio of good time to unscheduled down time is approximately 9.

The computer is part of a complete control system. The characteristics of the computer is determined by the characteristics required by the system in which it is to be used.

The flip flops and diode matrices are mounted on individual plug-in wafers and standardized as much as possible so that the bulk of the computer is a multiplicity of a few basic components. Etched circuits and subminiature tubes are used throughout.

INSTALLATIONS

Hughes Aircraft Company
Culver City, California

HUGHES BM GUIDANCE

Hughes Ballistic Missile Guidance Computer

MANUFACTURER

Hughes Aircraft Company
Digital Systems Department

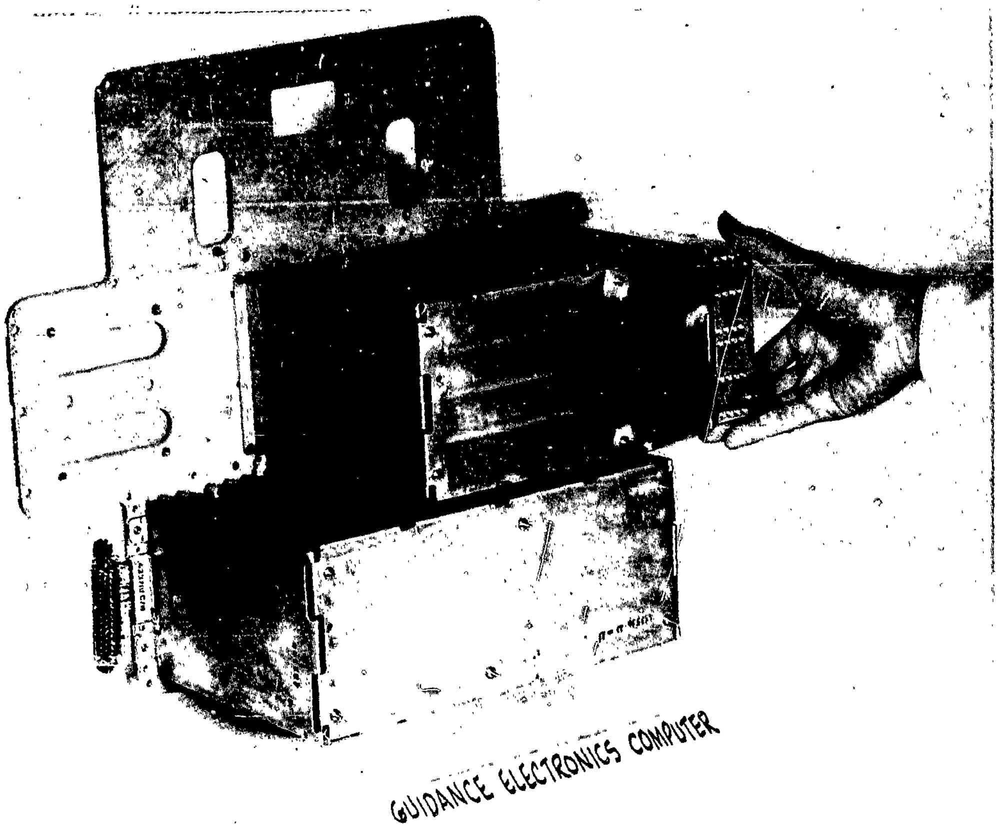


Photo by Hughes Aircraft Company

APPLICATIONS

System is a special purpose computer for guidance of ballistic missiles. It performs steering and timing calculations for the missile.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Cores	16	280	625 max.

Wired problem constants and programming.

INPUT

Media	Speed
Special Digital	81.6 Kilocycles/sec
Controlled by pre-launch digital computer	
Incremental Accelerometers	800 pulses/sec

OUTPUT

Media	Speed	
Digital	81.6 Kilocycle/sec	To pre-launch computer
Digital	50 Pulses/sec	To missile
Pulsed		To missile

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.030 Kw
Volume, computer	0.4 cu ft
Area, computer	1.1 sq ft
Weight, computer	23 lbs

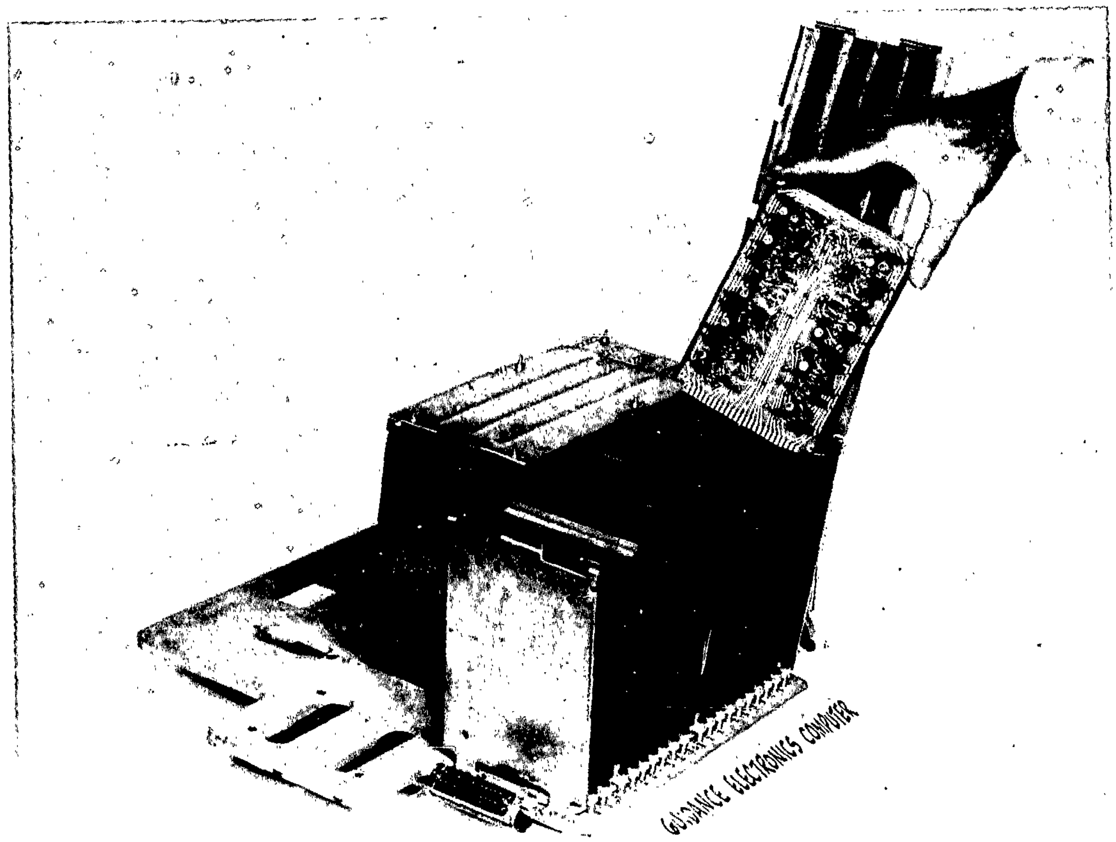


Photo by Hughes Aircraft Company

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Estimated mean-time-to-failure is greater than 1000 hours.
Above figures based on period from Feb 59 to May 60.
Date this system passed Customer Acceptance Test:
Development Apr 59, Final Jan 60.
Time is not available for rent to outside organizations.
Development model was operated continuously for 2200 hours with no failures.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include small volume, weight, power dissipation and high reliability. All solid state components, and replaceable subassemblies.

Adopted procedures for storage, shipping, and protection from humidity, temperature, and physical, electrical, fire, or other damages include molded polyurethene pads between subassemblies for shock absorption and thermal conductivity.

Special purpose digital differential analyzer, fixed programmed using "nor" logic elements. Consists of 21 logic cards, 2 clock cards, 2 input cards, 4 magnetic core cards, with redundant etching and connectors and 1 special "shift drive and oscillator" assembly.

HUGHES D PAT

Hughes Drum Programmed Automatic Tester

MANUFACTURER

Hughes Aircraft Company
Digital Systems Department

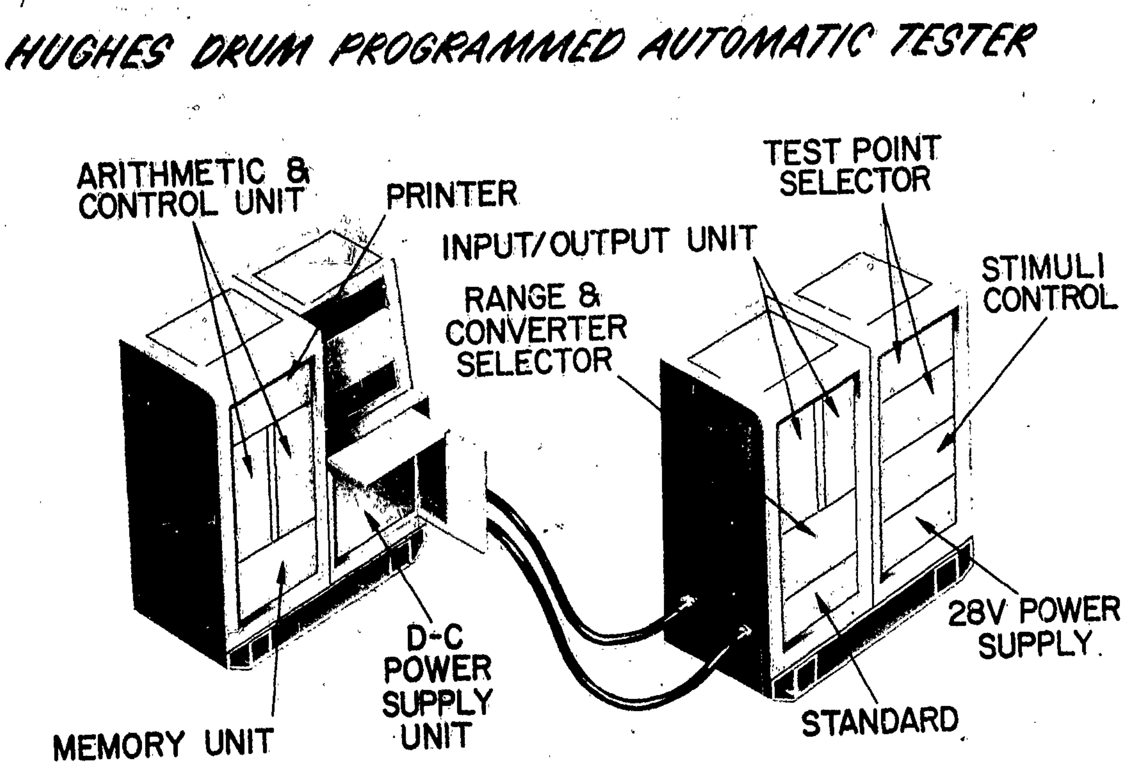


Photo by Hughes Aircraft Company

APPLICATIONS

System is used for automatic testing, checkout, fault isolation, sequencing and control of missiles, aircraft, vehicles, and electronic equipment.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	19
Binary digits/instruction	19
Instructions/word	1
Instructions decoded	40
Arithmetic system	Fixed point
Instruction type	Modified three address
Number range	$(1 - 2^{-18})$ to - 1

Instruction word format

<table>
<tr><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td></tr>
<tr><td colspan="7" rowspan="2">NEXT CHANNEL</td><td colspan="9">OPERATION AND ADDITIONAL SECTORS TO DELAY</td><td colspan="3" rowspan="2">SECTORS TO DELAY</td></tr>
<tr><td colspan="4">DESTINATION</td><td colspan="5">SOURCE</td></tr>
</table>

Automatic built-in subroutines
- Operator's console scanning and branching
- Visual display output
- Printer output
- Input selection and measurement
- Frequency measurement
- Bulk loading from tape

Registers
- 4 word register for frequency and time interval measurements
- 32 word register for digital and analog outputs

ARITHMETIC UNIT

Operation	Exclud. Stor. Access Microsec.
Add	84
Mult	84/bit
Div	84/bit

Construction (Arithmetic unit only)

Vacuum-tubes	0
Transistors	975
Diodes	6,300
Magnetic Cores	60

Arithmetic mode Serial
Timing Synchronous, Computer clock pulses recorded on magnetic drum memory
Operation Sequential

All times given in table above exclude access time to command. There are three 1-word accumulators, two 4-word circulating registers, one 16-word circulating register, and two 32-word circulating registers. The two's complement system of arithmetic is used.

STORAGE

Media	No. of Words	Access Microsec
Magnetic Drum	40,640	84 - 26,880
Magnetic Core	3	84
Magnetic Drum	8	84 - 336
Magnetic Drum	16	84 - 1,344
Magnetic Drum	64	84 - 2,688

All stored words are 19 binary digits

INPUT

Media	Speed
Analog Voltages A-C and D-C voltages	6000 samples/sec
Pulse and Analog Volt Frequency measurements	0.1 cps to 1 Mcps
Off-On Signals	6000 samples/sec
Decimal Keyboard	Manual
Paper Tape Reader Magnetic Drum Loading	400 char/sec

OUTPUT

Media	Speed
Contact Closures 1 to 10 bits/character	40 char/sec
Transistor switches 1 to 10 bits/character	168 microsec/char
Decimal readout panel 8 decimal digits plus sign	25 millisec/char
Analog Voltages Programmable A-C or D-C	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	0
Diodes (Crystal)	5,400
Transistors	1,800
Magnetic Cores	60

CHECKING FEATURES

Set of diagnostic test routines
Subunit checking facilities
Single order simulation with toggle switching
Partial program

Built-in test and maintenance equipment. Self-test program stored in memory to provide complete verification and fault isolation.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.3 Kw	0.3 KVA
Volume, computer	68 cu ft	
Area, computer	17 sq ft	
Weight, computer	1,800 lbs	

No special site preparations required. A 120/208, 3-phase, 4-wire, 400 cps power required.

HUGHES DIGITAIR

Hughes Digital Airborne Computer

MANUFACTURER

Hughes Aircraft Company
Digital Systems Department

MA-1 CENTRAL COMPUTER

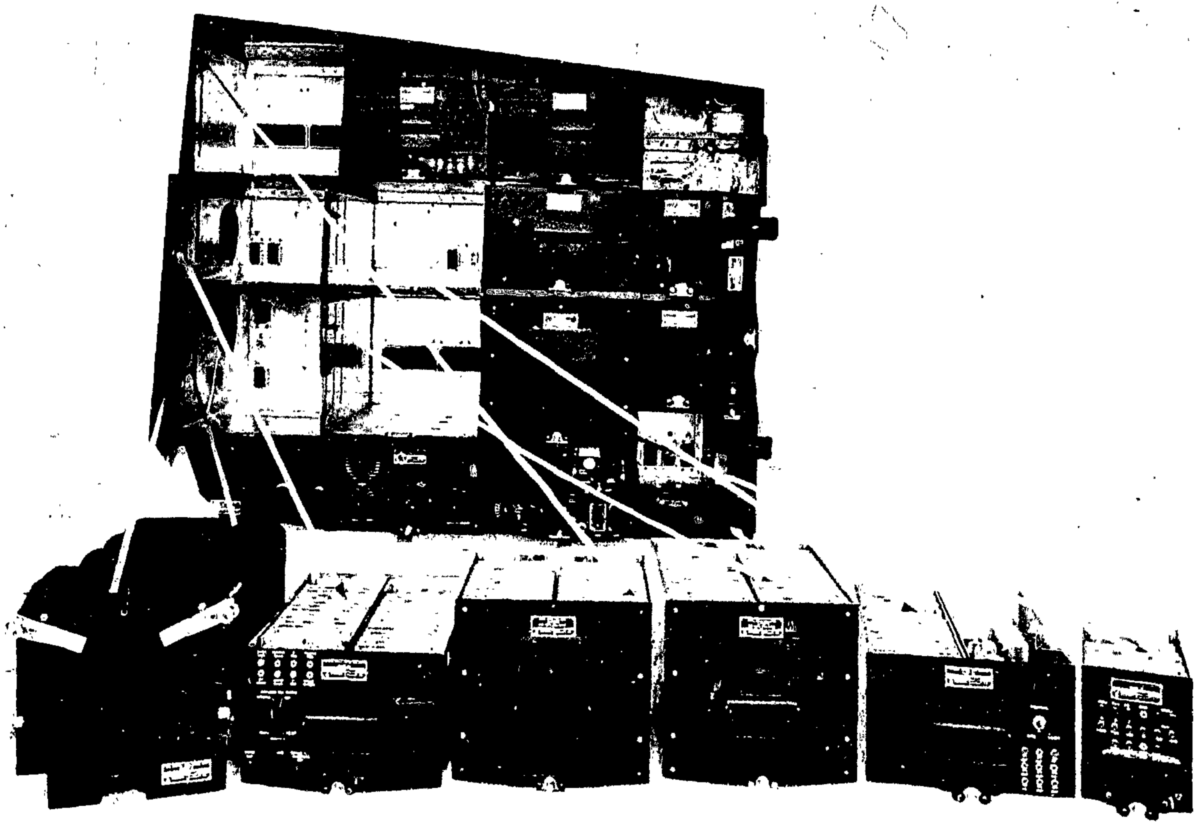


Photo by Hughes Aircraft Company

APPLICATIONS

Computer is used for real-time computing and control in complex aircraft systems. The computer includes extensive analog and digital input-output capability. In the application for which it was designed, the computer performs automatic aircraft control, navigation, attack steering, weapon control, intercept computation, data-link processing, and automatic system testing, for Air Force interceptors. In this application, the program and input-output are closely integrated with other electronic and mechanical portions of the system.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number binary digits/word	17
Number binary digits/instruction	17
Number instructions/word	1
Arithmetic system	Fixed point
Instruction type	Three address X-Modified
Number range	-1 to $(+1 - 2^{-17})$

Instruction word format

9 bits - relative address of next order	4 bits-source for data transfer	4 bits-destination for data transfer
	8 bits - instruction other than data transfer	

Automatic built-in subroutines include input conversion (analog, digital, data link) and output conversion (analog, digital) (independent of program).

Automatic coding includes conversion from mnemonic code to memory-loading tapes and program documents, via punched-card machinery. System is normally programmed in minimum-latency fashion.

Registers and B-boxes include 3 one-word registers, 2 multiword circulating registers for fast-access storage, 1 multiword circulating register for outputs, and 1 multiword circulating register for data link.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	210	105
Mult	variable-105 + 105/bit	105 per bit-variable
Div	variable-105 + 105/bit	105 per bit-variable

Construction (Arithmetic unit only)	
Vacuum-tubes	182
Transistors	None
Condenser-Diodes	1,926
Magnetic Cores	51
Arithmetic mode	Serial

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum, Pre-recorded	13,000	17	Min latency(normal)-104 Max possible- 12,500
Magnetic Drum, Variable	360	Same	Same
Magnetic Drum Register	22	Same	Min latency - 104 Max - 1040 or 1250
Core Shifting Registers	3		104

INPUT

Media	Speed
Voltages (ac and dc)	315 microsec conversion
24 inputs, electronically switched	
Pulses (Data Link)	5 KC
On-Off Signals	
54 inputs, electronically switched	
Inputs available to program on demand	

OUTPUT

Media	Speed
Voltages (dc)	0.5 sec full scale slew
16 silultaneous outputs	
On-Off Signals	10 microsec
Relay Contacts	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
6814	269 Flip-flops
6021	63 Triode Amps
5639	33 Write Amps
5703	18
5840	16
6110	10
Diodes	
90125	257
925002	147
925008	3,827
925010	6
925011	52
Diodes are Hughes type	
Transistors	0
Magnetic Cores	51

CHECKING FEATURES

Checking features include a fully automatic self-test program, remotely initiatable, making use of built-in self-test features. Semi-automatic diagnostic program diagnoses faults to one or two units. External equipment (ground-based) used for detailed diagnosis in conjunction with semi-automatic diagnostic program.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Volume, computer	3.2 cu ft
Volume, input-output	3.3 cu ft
Weight, computer	122 lbs
Weight, input-output	178 lbs
Weight, total	300 lbs

System mounted in aircraft electronics racks

PRODUCTION RECORD

Computer is in large scale production
Several hundred have been produced
Several hundred are on order

PERSONNEL REQUIREMENTS

Designed for operation and maintenance in unfavorable environments by military personnel with relatively little training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Total system time approximately 30,000 hours to date.
Mean time to failure approximately 60 hours, including input/output.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include the utilization of vacuum tubes and semiconductor diodes, very high maintainability, modified 2-address code designed for minimum-latency programming, serial fixed-point arithmetic, programmer can control input selection.

INSTALLATIONS

Various U. S. Air Force Bases

HUGHES LRI X

Hughes LRI X Computer AN/ASG 18

MANUFACTURER

Hughes Aircraft Company
Digital Systems Department

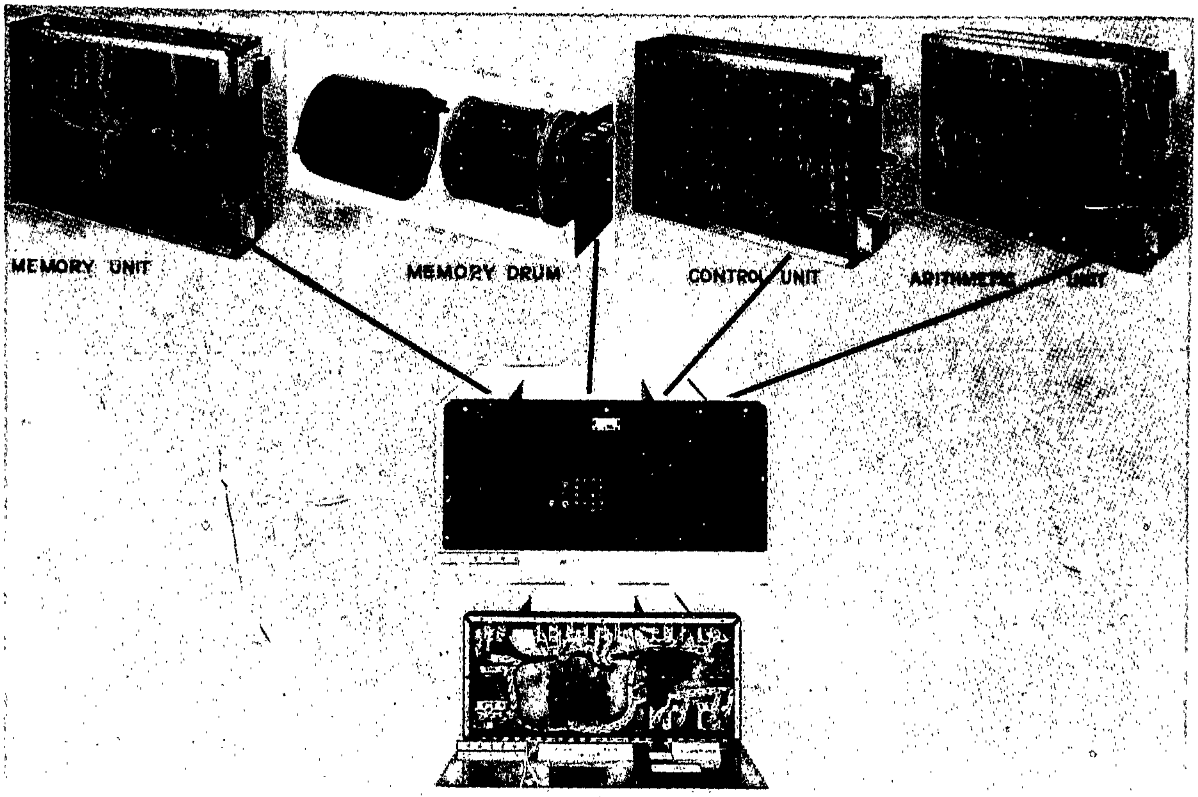


Photo by Hughes Aircraft Company

APPLICATIONS

System is used for real-time computing and control in complex aircraft systems. Computer includes advanced displays and extensive analog and digital input-output capability. In the application for which it was designed, the computer performs inertial and non-inertial navigation, weapon control, attack computations, data-link processing, intercept computations, and automatic tests of over-all system, for Air Force interceptors. In this application, the program and input-output are closely integrated with other electronic and mechanical apparatus in the over-all system.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	19
Binary digits/instruction	19
Instruction/word	1
Arithmetic system	Fixed point
Instruction	Modified three address
Number range	-1 to $(1 - 2^{-18})$

Instruction word format

9 bits relative address of next order	5 bits source of operand No. 1	3 bits source of operand No. 2 and destination	2 bits function

This structure applies to add, subtract, input, output, clear and absolute value. Other orders have slightly different structures.

Automatic built-in subroutines include input conversion (analog, digital, incremental, data link); output conversion (analog, digital, data link); real time count; frequency measurement (Independent of program).

Automatic coding includes conversion from simplified mnemonic code to memory-loading tapes and program documents, via IBM data processing machinery.

Registers include 4 one-word registers, 3 multiword circulating registers for fast-access storage, 2 multiword circulating registers for analog and digital outputs, 3 multiword circulating registers for data link processing, 1 multiword circulating register for frequency count, and 1 multiword circulating register for incremental inputs and real time count.

The system uses four-phase logic and is normally programmed in minimum-latency fashion.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Excl. Stor. Access Microsec
Add	84	84 (3 address code)
Mult	variable-84 + 84/bit	variable-84 per bit
Div	variable-84 + 84/bit	variable-84 per bit

Construction (Arithmetic unit only)

Vacuum tubes	none
Transistors	810
Arithmetic mode	Serial

STORAGE

Media	No. of Words	Access Microsec
Magnetic Drum, Pre-recorded	40,960	Minimum Latency (normal) - 84 Maximum possible - 25,000
Magnetic Drum, Variable	1,280	Same
Magnetic Drum Registers	188	Minimum Latency - 84 Maximum varies 84 to 1,700

INPUT

Media	Speed
Voltages (ac and dc) 64 inputs, electronically switched	200 microsec/conversion
Pulses (incremental and data link)	5 KC
On-Off Signals 130 inputs, electronically switched	
Operator Controls (Analog and Digital)	
Frequencies	100 KC

Inputs available to program on demand.

OUTPUT

Media	Speed
Voltages (dc)	0.7 sec. full scale slew
On-Off Signals (Toggles) 100 ma., 28 V.	
Shaft Positions	80 steps/second
Operator Displays (Analog and Digital)	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Transistors	1,683

CHECKING FEATURES

Checking features include fully automatic self-test program including marginal test, remotely initiatable, making use of built-in self-test features. Automatic self-diagnosis to unit level. Diagnostic program to aid more detailed diagnosis. External ground-based test equipment for detailed diagnosis, in conjunction with diagnostic program.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.850 Kw
Volume, computer	2.1 cu ft
Volume, input-output excl displays	1.7 cu ft
Weight, computer	135 lbs
Weight, input-output	50 lbs
Weight, total	185 lbs

System is mounted in aircraft

PERSONNEL REQUIREMENTS

System is designed for operation and maintenance in unfavorable environments by military personnel with relatively little training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Total system time is approximately 3000 hours to date.

Mean-time-to-failure approximately 150 hours including input-output.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include semiconductor circuits, very high maintainability, modified 3-address code designed to facilitate minimum-latency programming, serial fixed-point arithmetic, input-output flexibly accessible to program.

HUGHES M 252

Hughes M-252 Digital Computer

MANUFACTURER

Hughes Aircraft Company
Digital Systems Department

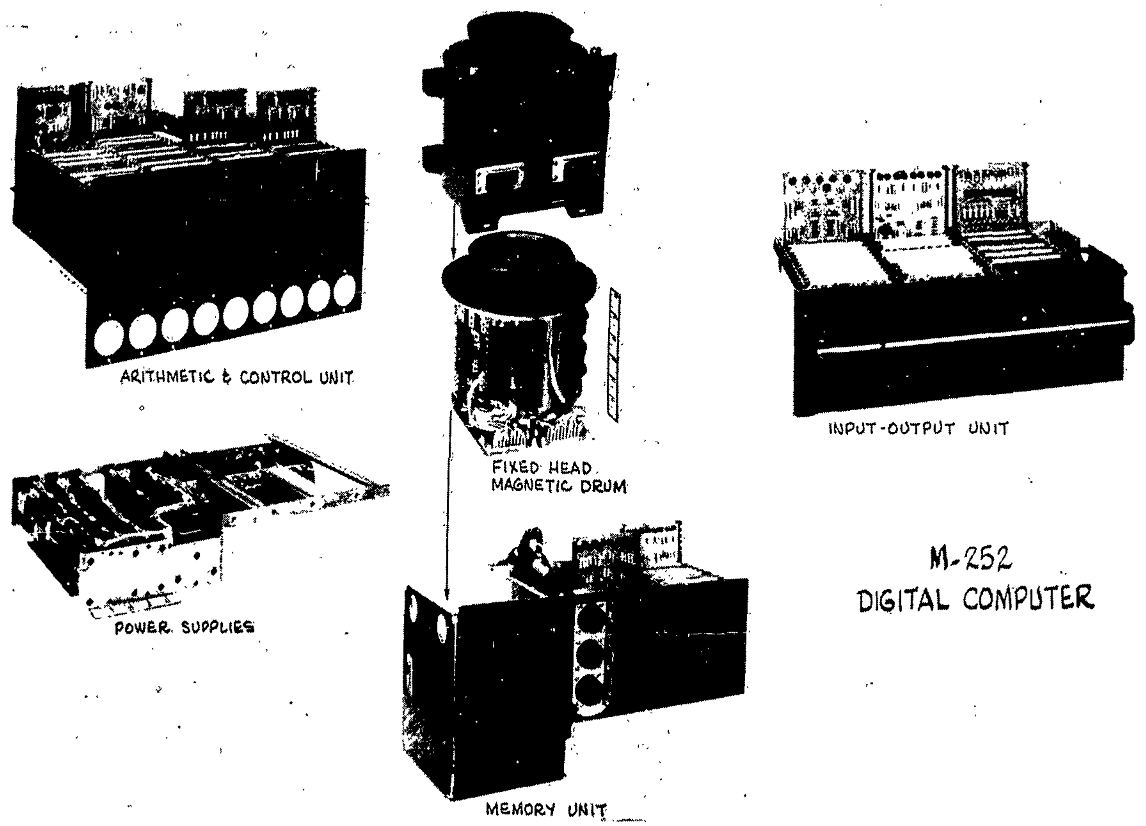


Photo by Hughes Aircraft Company

APPLICATIONS

The computer is currently being produced for use as a guidance computer to be used in a Minneapolis-Honeywell Inertial Guidance System for the Fairchild SD-5 Surveillance Drone. In this capacity, it aligns the platform, sets drift trims, performs the Schuler tuning of the platform, navigates the drone throughout the surveillance mission, turns sensors on and off, and feeds positional information to the data processor for proper identification of photographs.

A modified version of the computer is being designed for installation in a standard relay rack to be used as a ground based computer for space probe guidance.

PROGRAMMING AND NUMERICAL SYSTEM

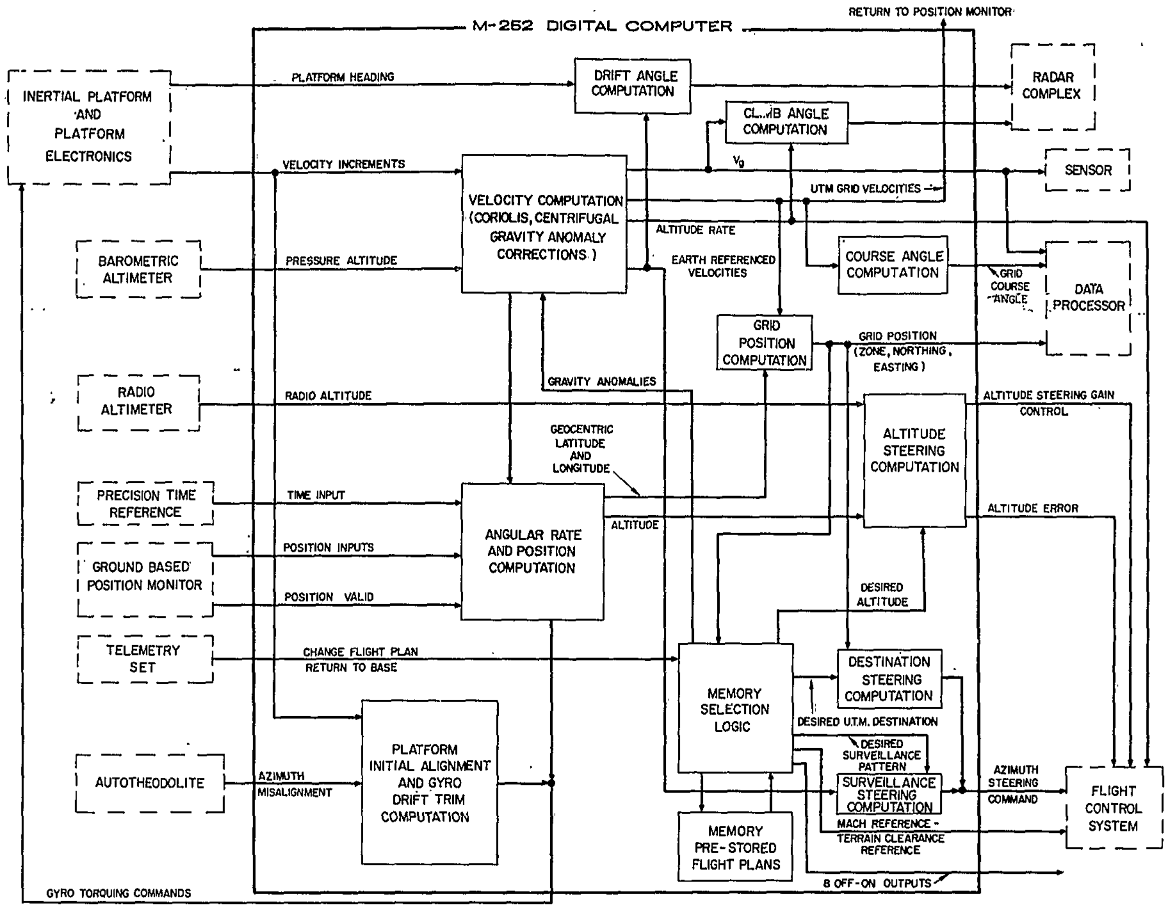
Internal number system	Binary
Binary digits/word	20
Binary digits/instruction	10
Number instructions/word	2
Arithmetic system	Fixed point
Instruction type	One-address
Number range	$-1 \leqslant N < 1$

Instruction word format

X X W W	X X X X X X Operation Code	X X Next Channel

XXXXX WW	X Left Right	XXXX Channel Group

(Second word of 2 word order when used)



M252 FUNCTIONAL BLOCK DIAGRAM

Chart by Hughes Aircraft Company

Registers include 3 - 1 word register for arithmetic operation, and 1 - 10 word register for short term temporary storage.

1 - 6 word register and 1 - 30 word register are used for Input-Output only.

4 temporary number storage channels are used.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec.	Exclud. Stor. Access Microsec.
Add	264	88
Mult	1144	968
Div	2112	1936

Construction (Arithmetic unit only)

Vacuum-tubes	0	
Transistors	750	Primarily 2N697, 2N1132, and 2N1253
Diodes	3000	
Magnetic Cores	66	
Arithmetic mode	Serial	

STORAGE

Medium	No. of Words	Access Microsec
Magnetic Drum	2,640	88

Access time is minimum

An additional 14 channels of 60 words are used for input-output registers, temporary storage, word-origin origin track, clock pulse tracks, and spare channels. A fixed head drum has been used in this application for maximum reliability.

INPUT

Media	Speed	Remarks
2 Serial Digital	250 KC	
3 Incremental	3600 sec (max.)	Pulses
6 Switching	Program Control	
2 A-C		0 to 8 V
3 D-C		-8V to +8V
Timing Reference	400 cps	

DC conversion accuracy ± 0.3 percent.

OUTPUT

Media	Speed	Remarks
1 Serial Digital	250 KC	
3 Incremental	1800 sec	Torquing Commands
10 Switching	Program Control	
11 D-C	Continuous	-8V to +8V

D-C conversion accuracy

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	0
Diodes	4,000
Transistors	1,100
Magnetic Cores	66

CHECKING FEATURES

Prior to use, the computer is checked by a self-test program of 70 seconds duration.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, system	0.37 Kw	0.46 KVA 0.6 pf
Volume, system		2.13 cu ft
Capacity, air conditioner		2.3 lbs/min cooling in at 110°F
Weight, system		85 lbs

Above figures include power supply and input-output equipment. Central computer is 1.3 cu ft and 53 lbs.

Computer is designed for airborne installation. A test control unit and drum record unit are required for loading the drum and checking the computer prior to flight.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Date this system passed Customer Acceptance Test 14 April 60

Estimated mean-time-to-failure is greater than 400 hours. The limited experience to date tends to bear this out.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include design for 5G vibrations without isolators. Operates over temperature range from -67°F to +185°F. All modules are repairable.

Unique system advantages includes high accuracy navigation performance in conjunction with a high quality inertial platform.

FUTURE PLANS

Versions of this computer have been proposed for several applications. A contract has been received for a relay rack version to serve as a ground based computer for space probe guidance.

INSTALLATIONS

System is for field use in the Fairchild SD-5 Drone.

IBM 305 RAMAC

IBM 305 RAMAC Data Processing System
Random Access Method of Accounting and Control

MANUFACTURER

International Business Machines Corporation

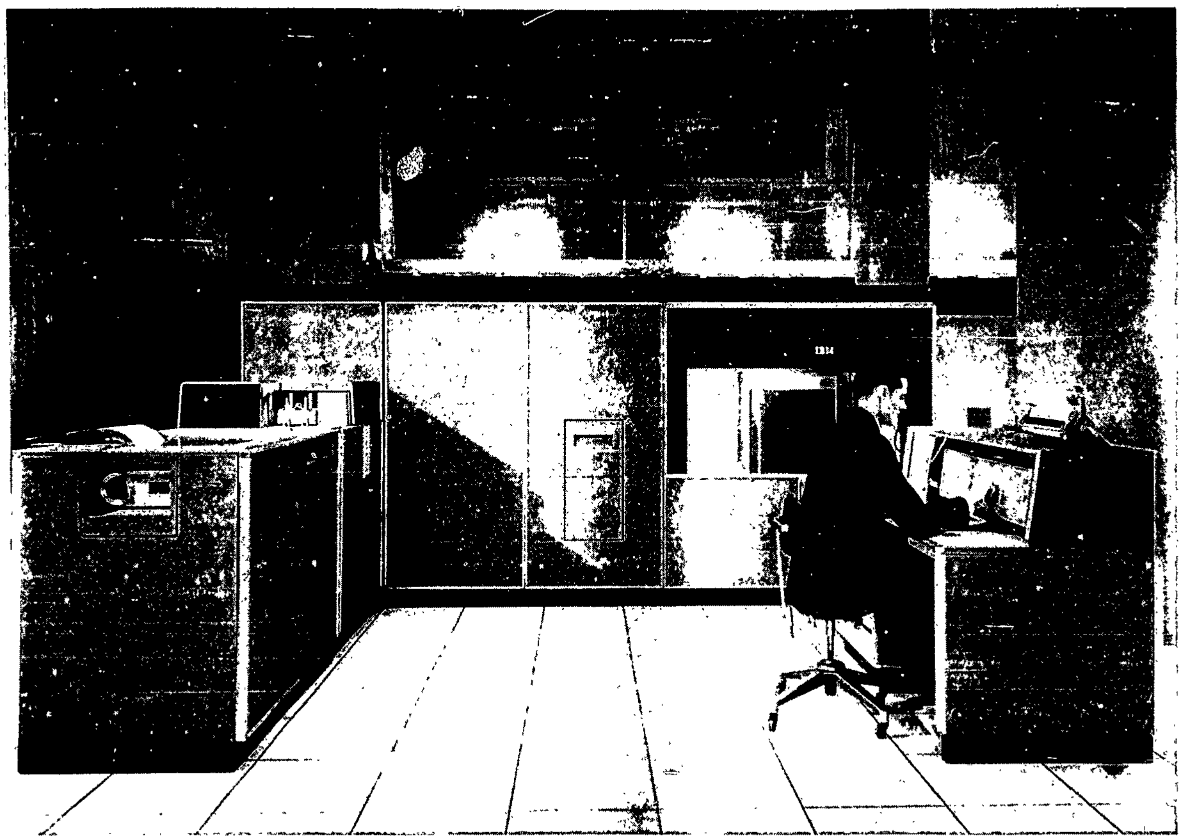


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

Inventory control, manufacturing control, billing (invoicing and order writing), parts substitution, payroll, hospital accounting, sales analysis, accounts receivable, fiscal accounting, and Air Force parts inventory and accounting.

The IBM RAMAC 305 (Random Access Method of Accounting and Control) is a complete, compact data processing system built around a disk memory unit which consists of 50 magnetic metal disks. The RAMAC 305 is designed to provide continuous, or "in-line", accounting for all types of businesses. Data is recorded on or read from each side of the disks in random order by a rapidly-moving access arm. The disk units are available with storage capacities of 5 million digits and 10 million digits and may be used either singly or in any combination of two to provide storage capacities of 5, 10, 15 and 20 million digits.

Control center of the IBM RAMAC 305 is the operator's console. The system also has arithmetical and logical ability, punched card input, and both punched card and printed output. Additional features which may be added to this basic RAMAC for further versatility include punched paper tape input, remote printing stations, dual disk files, dual access arms, dual system control, and faster, more flexible printing.

Letterkenny Ordnance Depot

Located in Building No. 3, Letterkenny Ordnance Depot, Chambersburg, Pa., the system is used to apply ADPS only to accomplishment of supply, stock management and related financial accounting functions with a view of expediting supply and providing a means of rapid expansion of activity without a proportionate increase in personnel and equipment. Experience and skills gained in these applications will facilitate progressive integration of other applications utilizing the same basic system by adding relatively inexpensive disk storage units. Such applications include payroll, cost accounting, etc.

U.S.A. Louisville Medical Depot

Located at the Louisville Medical Depot, Louisville 1, Kentucky, the system is used for stock accounting and inventory control (Navy Single Manager), for depot property accounting, and for Post Engineer property accounting.

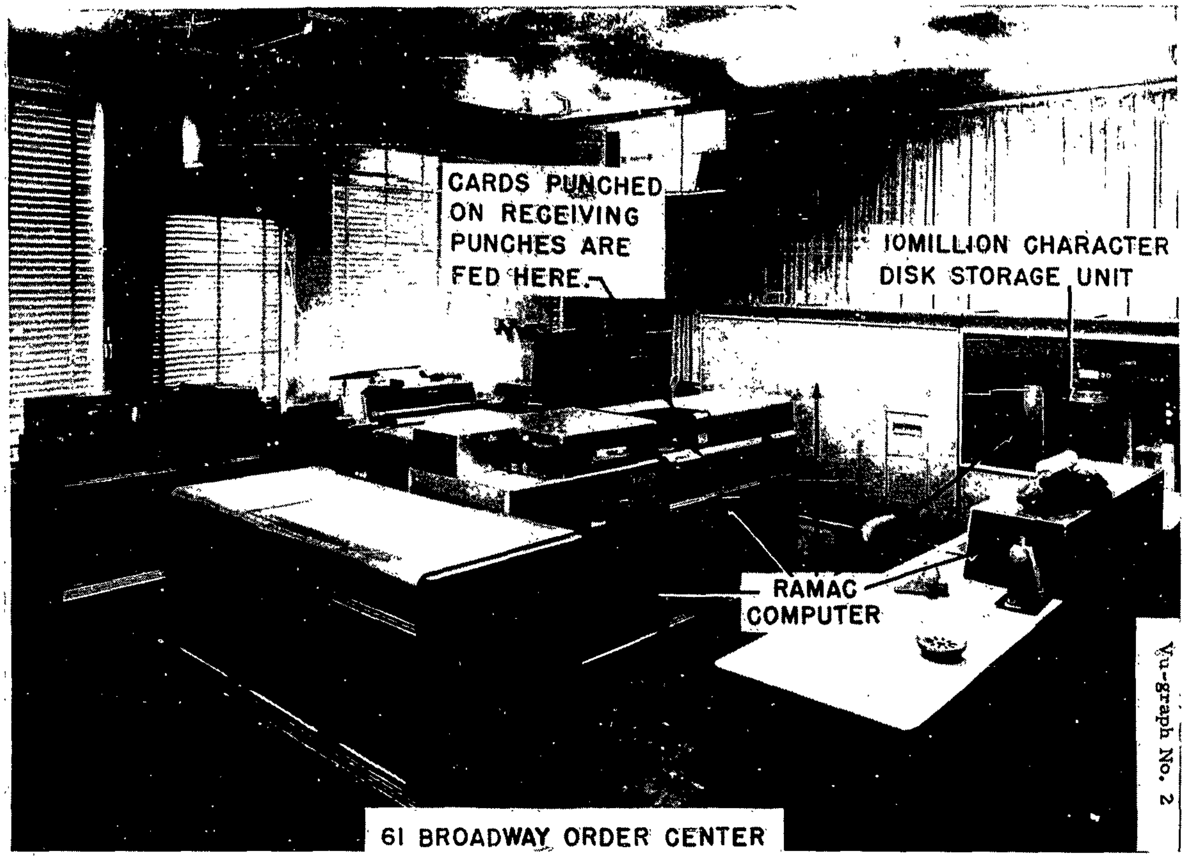


Photo by Western Electric Company

U.S.A. Mt. Rainier Ordnance Depot
Under the Director for Services, the system is used for supply and inventory accounting and for financial and stock fund accounting.

U.S.A. Raritan Arsenal
System is used for distribution supply, availability editing, and F. I. A. updating and reporting.

U.S.A. Red River Arsenal
Maintenance of stock accounting and related financial records to include daily updating of all quantitative fields, periodic updating of pertinent data in each record, daily processing of all type transactions (issues, receipts, adjustments, etc.) and creating documentation for same in punched card form.

U.S.N. Charleston Shipyard
Located in the Supply Department, fields of application include expenditure processing (processing issues of all types, including availability tests, reorder initiation, and attendant funds control), receipt processing (all types of material receipts), stock record load/unload (loading and unloading stock records as required), obligation/planned requirement review (cyclic review of material obligations (back orders) and planned requirements), status read-off (to provide visible records for review as required), warehouse location load (to insert warehouse locations into stock records), stock status reporting (to report status of items in accordance with schedules established by supply demand control points), inventory cut-off to provide inventory cut-off and trial balance cards for inventories of material, and other miscellaneous calculating programs.

USAF 78 Fighter Wing, Hamilton AFB
Located at Base Supply, Hamilton AFB, California, the system is used for automation of supply record keeping. Includes all transactions effecting balances, due-in and due-outs, item records, inventory control. Incompasses records for 46,000 line items (averages) with 72,000 transactions per month.

USAF Hq SAC Offutt AFB
With 19 locations in the command, (sites and program are similar), the 305 EDPS has been designed to increase dependability of supply activities in support of SAC combat-readiness through an improved mechanized system. The design of the system provides for:

Instantaneous and positive response by on line processing.

The immediate and automatic availability of all interchangeable assets.

The immediate and automatic availability of like items in all weapons systems.

The immediate and automatic requisitioning of not-in-stock items.

Guaranteed increased required items availability.

Accurately computed stock levels after every appropriate transaction.

Automatic stock replenishment requisitioning.

Current and accurate stock balance consumption reports.

Provides an integrated item and monetary accounting

Photo by U. S. Army Red River Arsenal

system simultaneously updating monetary balances at the same time item balances are updated.

The designing and programming of the EDPS features the accomplishment of supply transactions with a minimized possibility of human error. With this increased accuracy comes increased supply effectiveness for our combat organization.

USAF 328th Fighter Group, Richards-Gebaur AFB
Located in Building 619, Richards-Gebaur Air Force Base, Missouri, the system is used for base supply item and dollar accounting. Maintains the supply accounting and financial accounting records on a current basis by automatically updating in accordance with various transactions affecting these records in accordance with Volume XVIII, AFM 67-1. By-products of this system provide management documents containing information needed to satisfy requirements for consumption rates, supply requirements, transaction analysis, item location and expense distribution.

Boeing Airplane Company
Located in Boeing Warehouse No. 3, Wichita, Kansas, the system is used for maintenance of an inventory of government furnished parts located at Boeing-Wichita.

Ford Motor Company, Transmission & Chassis Div.
System is used for payrolls and related accounting, inventory control, production analysis and control, product cost and cost analysis reports.

Ford Motor Company, Wayne
Located at the Wayne Assembly Plant, the system is used for inventory control of productive material, vehicle invoicing and price labels, manufacturer's certificate of origin, and pricing and calculations for payment to vendors.

Sun Oil Company, Philadelphia 3
Located at 1608 Walnut Street, Philadelphia 3, Pa., the system is used for payroll preparation, payroll accounting, and deduction and payroll tax accounting.

Sun Oil Company, Southland Center
Located at Southland Center, Dallas, Texas, the system is used for computation of volumes of natural gas produced, used, and disposed of and valuing, taxing, and accounting for proceeds for natural gas and natural gas liquids, including disbursement of proceeds to all interested parties.

Western Electric Company, Aurora
Located at the Montgomery Shops, Aurora, Ill., the system is used for inventory and production control of relay manufacture, including scheduling relays, components and raw material requirements, input, billing and investment control of relay accounting.

Western Electric Gen Prog Comm New York
Located at 222 Broadway, New York, the system is used to process customers' orders and enter such orders on appropriate sources of supply. It also maintains records of purchase contract balances.

Western Electric Co., Tel. Sales Div., New York
Located at 61 Broadway, 4th Floor, New York 6, New York, this computer is used to develop programs prior to the installation of similar RAMAC Systems in the Distributing Houses (Regional Warehouses and repair shops). The primary application is inventory control including billing, maintaining stock balances, ordering, receiving and vouchering; all on an inline basis. Shop costing, shop scheduling payroll and headquarters reporting are batch processed. This computer has been used to develop and test the Dataphone III Transmission System. Monthly operating statistics from all the Distributing Houses are verified and summarized for printed monthly reports.

Western Electric, Winston-Salem
The system is used for production control, including inventory control, machine load, material movement, order requirements and schedule, and shop orders.

Georgia State College of Bus. Admn.
Located at 33 Gilmer St., S. E., Atlanta 3, Georgia, the machine is used in faculty research and in the teaching of programming methods.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded alphanum
Alphanumeric char/record	Up to 100
Alphanumeric char/instruction	10
Instruction/Process Drum Track	10
Instructions decoded	200 on 10 tracks, std.
Arithmetic system	Fixed point
ADD-SUBTRACT-MULTIPLY-DIVIDE	
Floating point	By program sub-routine.
Instruction type	Two address
Control panel logic (stored program) also.	
Number range	Decimal 0 - 9

Instruction word format

FROM	TO	NO. CHAR.	CONTROL

Automatic coding includes the RAMAC Symbolic Assembly Program.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	30,000
Mult	60,000-190,000
Div	100,000-370,000

Construction (Arithmetic unit only)

Type	Quantity
Tubes	
2D21	21
6211	169
6350	20
5919	124
7044	4
Diodes	
AM	12

Timing	Asynchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	Access Microsec
Process Drum	Tracks	10,000
Disk File	100 char/record 50,000 records/file	600,000 avg.

10,000,000 char with 2 files

Disk File	100 char/record 100,000 records/file	600,000 avg.

20,000,000 char with 2 files

Magnetic Tape (Special Order)

No. of units that can be connected	3 Units 729-I 4 Units 727
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Char/sec
Start time	10 Millisec
Stop time	10 Millisec
Average time for experienced operator to change reel of tape	90 Seconds
Physical properties of tape	
Width	0.498 Inches
Length of reel	2,450 Feet
Composition	Mylar base

Connects through 1901 Tape Control Unit (Special Order).

USA LOD

Medium	No. of Char	Access Microsec
Disk Storage	30,000,000	30,000

20 program tracks, 10 working tracks, 4 input-output tracks and 1 accumulator track per processing unit (two units); 3 type 350 double density files.

USA Medical Depot

Magnetic Disk 10,000,000

Track to track access time same disk 100,000 - 25,000 microseconds.

Disk to disk access time 400,000 - 800,000 microsec.

USA Mt Rainier Ord D

Medium	No. of Words	No. of Digits
Magnetic Disk Memory	200,000	20,000,000

5 - 10 seconds required per transaction.

100 characters to a record, twenty 100 character records on each 100 tracks on each 50 disks.

USA Raritan

Medium	No. of Words	No. of Char	Access Microsec
Magnetic Disk (2)	100,000 ea	10,000,000 ea	600,000
Magnetic Drum (2)	200 ea	2,000 ea	

Magnetic drum used for storing program and processing data.

Magnetic disk used primarily for bulk storage.

Both disk units under control of console A and B. This is dual control and dual access.

USA Red River Arsenal

Disk Files	300,000	30,000,000	4,000 avg.
High Speed Magnetic Drum	300	3,000	300 avg.

Each record stored consist of 100 digits each.

Hamilton AFB

Medium	No. of Char	Access Microsec
Magnetic Disk	5,000,000	500

50 disks has 100 tracks each of which is divided into ten 100 character records. This provides 5 million characters of storage or 50,000 addressable records.

Offutt AFB

Media	Alphanum Char	Access Microsec
Disk File	10,000,000	600,000
Core	100	5,000
Magnetic Drum	3,300	5,000

USAF Richards-Gebaur AFB

Medium	No. of Char	Access Microsec
Disk File	5,000,000	600,000

Boeing, Wichita

Disk	5,000,000	600,000
Drum		

There are 34 tracks on the drum (19 program tracks, 8 working or storage tracks, 2 accumulator tracks, 1 typewriter track, 1 punch output track, 1 printer output track, 1 multiplicand track and 1 input track).

WE Winston-Salem

Medium	No. of Records	No. of Char	Access Microsec
Magnetic Disk	200,000	20,000,000	600,000

INPUT

Manufacturer

Media	Speed	
Cards	125 cards/min	380 Console Card Reader
Paper Tape	20 char/sec	382 Paper Tape Reader
Card	125 cards/min	797 Card Read Punch
Inquiry Input	Variable	380 - 381 Keyboard
Magnetic Tape (Special Order)	15 Kc	727, 729 I Tape Unit

USA LOD

Card Reader (2) 125 card/min, ea. 2 type 380 consoles

USA Medical Depot

Punched Card 125 card/min, max

Card speed depends on application under control of program.

USA Mt Rainier Ord D

Additions	5 sec	300 lines
Receipt	5 sec	500 lines
Adjustments	5 sec	300 lines
Issues	9 sec	1,500 - 2,500 lines

Receipts and adjustments 300 program steps.
Financial inventory accounting 1,150 steps.
Customer demands 550 steps.
File maintenance 900 steps.

USA Raritan

Cards	125 cards/min	Card Reader on Console A
Cards	125 cards/min	Card Reader on Console B

USA Red River Arsenal

Punched Cards 250 cards/min

Two card readers, 125 cards/min each.

USN CNS

Cards 125 cards/min, maximum

Hamilton AFB

Card-Mainline Routine	18.4 sec/trans	46,639 transactions
Card-File Maintenance	7.6 sec	26,516 transactions
Card-Stock Leveling	2.2 sec	26,397 transactions
Card-Requisitioning	7.8 sec	26,711 transactions

Each routine has a different input speed. Examples are given are the most frequently used and speeds and transactions are averages.

Offutt AFB

Medium	Speed
Card	125 cards/min

USAF Richards-Gebaur AFB

Cards 125 cards/min

This speed is maximum and will decrease depending on type of processing being accomplished.

WE TSD New York

380 Card Reader 125 cards/min, max.
797 Card Reader-Punch 120 cards/min, max.

This machine is an adapted 537 Reader Punch of IBM 650 System. The 797 is a combination card reader and punch. This machine moves the cards to various stations in a parallel motion. The machine has 2 sets of read brushes, punch, and a punch read brush station for checking.

OUTPUT

Manufacturer

Media	Speed	
Card	100 cards/min	323 Card Punch
Printer	150 lines/min	407 R1-R2 Printer
	29-84 lines/min	370 Printer
Typewriter	10 char/sec	381 Remote Printing Station
		380 Console Typewriter
Card	125 cards/min	797 Card Read-Punch (Special Order)
Magnetic Tape (Special Order)	15 Kc	7[illegible], 729 I Tape Unit

USA LOD

Medium	Speed	
Card Punch (4)	100 cards/min, ea	4 type 323 Punches
Typewriter (2)	10 char/sec	

USA Medical Depot

Punch	100 cards/min
Printer	150 lines/min
Typewriter	600 strokes/min

Speeds depend on application under control of program.

USA Raritan

Cards (2)	100 cards/min ea	IBM 323 Card Punch
Cards (2)	100 cards/min ea	IBM 323 Card Punch
Printed Document	10 char/sec	Console-typewriter
Printed Document	10 char/sec	Console-Typewriter

Typewriter mounted on console used largely for inquiries. There are four card punch units on line.

USA Red River Arsenal

Cards 400 cards/min

Four punch units at 100 cards/min.

USN CNS

Cards	100 cards/min, max
Printed Documents	150 lines/min, max

Hamilton AFB

Media	Speed	
Card-Mainline	5.4 sec	160,177 transactions
Card-File Maintenance	3.8 sec	52,402 transactions
Card-Stock Leveling	3.3 sec	17,410 transactions
Card-Requisitioning	10.8 sec	19,307 transactions

Each routine used has a different output speed. Examples given are the most frequently used and speeds and transactions are averages.

Offutt AFB

Card Punch	100 cards/min
Printer	30-175 lines/min
Typewriter	10 char/sec

USAF Richards-Gebaur AFB

Cards	100 cards/min
Printed Listings	30 lines/min
Type Listings	6 lines/min

Media	Speed	
Boeing, Wichita		
Card	100 cards/min	
Printer	80 positions	30 lines/min
	20 positions	83 lines/min
Typewriter	100 char/line	6 lines/min
Ford Motor Company		
Cards	100 cards/min	
Printed Document (407)	150 lines/min	
Printed Document (Typewriter)	60 lines/min	
Ford, Wayne		
Card (Type 323)	100 cards/min	
Printer (Type 370)		
Printer (Type 407)	105 lines/min	
Summary Punch (Type 523)	2 cards/min (Dependent upon application)	

The 407 and 523 are added on line, but not used for all applications performed on the RAMAC.

SUNOCO Philadelphia		
Printed Page	150 lines/min	IBM 407 on line
Typed Page	RAMAC 305 Typewriter	
Punched Card	100 cards/min	
SUNOCO Southland Center		
Punched Cards	100 cards/min	
Stick Printer	30 to 80 lines/min	
Typewriter	10 char/sec	
WE Aurora		
Card	100 cards/min	
Printer (80 positions)	29 lines/min	
WE GPC New York		
Type 323 Card Punch	100 cards/min	
Type 370 Printer	29 lines/min	
Type 407 Printer	150 lines/min	
WE TSD New York		
797 Card Reader-Punch	120 cards/min	
323 Punch	100 cards/min	
380 Typewriter	10 char/sec	

Typewriter format control is possible, but infrequently used.

WE Winston-Salem	
Cards	100 cards/min
Printer	125 lines/min
Georgia State	
Card	100 cards/min
Printer	83 lines/min (20 positions)
Printer	30 lines/min (80 positions)
Typewriter	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity	
Tubes		
6211	1,054	
6350	81	
5919	626	
7044	72	
2D21	205	
5965	6	
Diodes		
AB	13	
AD	2	
AM	112	
AL	275	
F	4	
Magnetic Cores		
14	100	
Selenium Rectifiers	360	(IBM P/N 315903 (For stacks of 10)
Germanium Rectifiers	28	IBM P/N's 2100111, 2100110, 2100119, 2114085, 2100108, 512073.

CHECKING FEATURES

Manufacturer

Built-in checking features include parity (odd bit) on all internal data transfers and printing, input from cards by two readings, and input from paper tape by count of data punches by record (T.C.C.C.).

Programmed checks include control to pre-established totals, comparing addresses and part numbers in program, and arithmetic proof factors and reverse arithmetic in program.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	12.6 KVA
Area, computer	370 sq ft
Room size, computer	18 ft 1 in x 20 ft 4 in(min)
Floor loading	50 lbs/sq ft
Capacity, air conditioner	4 Tons

Humidity not to exceed 80%. Two feet of headroom above 350 Unit. Physical Planning Manual and assistance are available.

USA LOD

Power, computer	42.5 Kw	53.1 KVA
Power, air cond	20 Kw	14 KVA
Volume, computer		856.4 cu ft
Volume, air conditioner		9,375 cu ft
Area, computer		178 sq ft
Area, air conditioner		400 sq ft
Room size, computer		40 ft x 40 ft
		1,600 sq ft
Room size, air conditioner		25 ft x 25 ft
Floor loading		36.8 lbs/sq ft
		543 lbs concen max
Capacity, air conditioner		62.5 Tons
Weight, computer		18,484 lbs

1,600 ft. (40 x 40 ft) were inclosed within the Machine Accounting Services area which in itself was an inclosure of 167 x 87. Although the entire area was air-conditioned, additional ducts and vents were concentrated in the computer area.

USA Medical Depot

Power, computer	16.4 KVA at 208 volts
	44.9 amps at 208 volts
Volume, computer	914.4 cu ft
Volume, air conditioner	48,000 cu ft
Area, computer	146.3 sq ft
Area, air conditioner	3,200 sq ft
Room size, computer	18 ft 1 in x 20 ft 4 in
Floor loading	50 lbs/sq ft
	50 lbs concen max
Capacity, air conditioner	20 Tons
Weight, computer	8,432 lbs

Space in same building with conventional EAM equipment was available. Wiring for 3-phase, 208 volt, 100 ampere power supply, including receptacles and a separate transformer was installed. Air conditioning was available; however, humidity control was added. Temperature range is maintained at 60° to 80°F and humidity is maintained between 40% and 60% relative. The following components of the 20-ton air conditioner with an evaporative condenser are operated from a 120/208 V, 3-phase, 4 wire grounded "Wye":

Electrical system refrigeration compressor motor - 20 H. P.; supply air fan motor - 5 H. P.; evaporative condenser motor - 3 H. P.; 1 zone re-heat of 18 Kw; and 1 zone re-heat of 25 Kw.

Unit is equipped with electric control system with humidistat controlling of coil temperature. Thermostat controlling re-heat. Operation is checked with recording thermometer and hygrometer equipped

with alarm facilities.

USA Mt Rainier Ord D

Power, computer	34.4 KVA	0.90 pf
Power, air conditioner	29.0 Kw	0.90 pf
Volume, computer	50.54 cu ft	
Volume, air conditioner	103.68 cu ft	
Area, computer	152.40 sq ft	
Area, air conditioner	15.36 sq ft	
Room size, computer	50 ft x 20 ft	
Room size, air cond	12 ft x 12 ft (Area 2 in car decking 2nd floor	
Floor loading	109 lbs/sq ft (dist load) 1,800 lbs/sq ft (pressure under greatest load)	
Capacity, air conditioner	15 Tons, total (2 sys)	
Weight, computer	8,299 lbs	
Weight, air conditioner	1,850 lbs	

The RAMAC room is located in one end of a frame warehouse converted to office space. The room height is 11 ft 2 in. with a honeycomb false ceiling 9 ft from tile floor. The room is illuminated by 42 8 ft flourescent tubes (strip) and has a distribution of approximately 60 ft/candles. A unique feature is the perforated hardboard wall which acts as the air distribution panel from the air conditioner mounted on the second floor. The air conditioner duct system has a 117 inch wide x 16 inch deep x 30 in high plenum chamber. Aerial services is provided from three (3) new 25 KVA XFMR's. Floor is 6 inch reinforced concrete on grade.

USA Raritan

Power, computer	40.1 Kw	44.2 KVA	0.90 pf
Power, air condi	18.9 Kw	21 KVA	0.90 pf
Volume, computer (2)	13,750 cu ft		
Volume, air conditioner (Dunn & Bush Package - Water)	960 cu ft		
Area, computer (2)	1,375 sq ft		
Area, air conditioner	80 sq ft		
Room size, computer	25 x 55 x 10 ft		
Room size, air conditioner	8 x 10 x 12 ft		
Floor loading	1,000 lbs/sq ft 4,000 lbs concen max		
Capacity, air conditioner	20 Tons		
Weight, computer	17,500 lbs		
Weight, air conditioner	2,100 lbs		

Site preparations included existing building, masonry walls, concrete floor, and wood roof deck with automatic water sprinkler. Leveled and tiled floor and removed wood columns. Hung fire resistant insulated ceiling and installed duct work for air conditioning. Replaced partitions with fire resistant material. Installed electric lighting and power, and air conditioning unit.

USA Red River Arsenal

Power, air condit	52 Kw	59.1 KVA	0.87 pf
Volume, computer	800 cu ft		
Volume, air conditioner	3,960 cu ft		
Area, computer	160 sq ft		
Area, air conditioner	330 sq ft		
Room size, computer	1,200 sq ft		
Floor loading	50 lbs/sq ft		
Capacity, air conditioner	44 Tons		
Weight, computer	19,540 lbs		
Weight, air conditioner	14,000 lbs		

Air conditioning services an additional 2,000 sq ft of machine area.

USN CNS

Power, computer	17.6 KVA	230 V. AC
Power, air conditioner		230 V. AC
Volume, computer	858 cu ft	
Area, computer	143 sq ft	
Room size, computer	21 ft x 25 ft	
Room size, air conditioner	Ceiling mounted	
Floor loading	125 lbs/sq ft	
Capacity, air conditioner	10 Tons	
Weight, computer	11,065 lbs	

False ceiling and walls, rewired for lighting, rewired for power distribution, refloored in tile.

Hamilton AFB

Power, computer	12.6 KVA 208V, 34.5 amps 60 cycle, 3 phase, 4 wire service
Power, air conditioner	220 V. 3 phase, 60 cycle
Volume, computer	375 cu ft
Volume, air conditioner	48 cu ft
Area, computer	18 ft x 20 ft
Area, air conditioner	8 sq ft
Room size, computer	24 ft x 24 ft
Floor loading	50 lbs/sq ft
Capacity, air conditioner	7 1/2 H. P.
Weight, computer	10,162 lbs (two disk storage unit (1730 lbs ea)
Weight, air conditioner	750 lbs

A total of $17,616.00 was expended to prepare 24 ft x 24 ft room for the machine, a 324 sq ft room for key punchers, a 576 sq ft for programmers from existing facilities. Breakout of costs: Air condition unit - $1,400, exhaust fan - $285, cooling tower - $500, electrical work - $7,256, ductwork - $325, material $4,440, and labor for the balance.

Offutt AFB

Power, computer	16.4 KVA	208V
Power, air conditioner		220V
Volume, computer	8,000 cu ft	
Volume, air conditioner	240 cu ft	
Area, computer	800 sq ft	
Area, air conditioner	24 sq ft	
Room size, computer	20 ft x 40 ft	
Floor loading	50 lbs/sq ft 50 lbs concen max	
Capacity, air conditioner	5 Tons	
Weight, computer	8,432 lbs	
Weight, air conditioner	500 lbs	

Must be enclosed in a dust free room with humidity control not to exceed 80% relative humidity at any time. Must have lightning arrestors, 2 4-wire branch circuits with voltage from either a 208 or 230, 60-cycle 3 phase 4-wire service line not to exceed + or -10%.

USAF Richards-Gebaur AFB

Power, computer		15.1 KVA	
Power, air condit	12.7 Kw	25.8 KVA	0.5 pf
Volume, computer	3,240 cu ft		
Volume, air conditioner	378 cu ft		
Area, computer	1,536 sq ft		
Area, air conditioner	54 sq ft		
Room size, computer	20 ft 4 in x 18 ft 1 in		
Room size, air conditioner	6 ft x 9 ft		
Floor loading	55 lbs/sq ft		
Capacity, air conditioner	15 Tons		
Weight, computer	8,925 lbs		
Weight, air conditioner	2,250 lbs		

Air conditioning and soundproofing.

Boeing, Wichita

Power, 340 Power Unit	12.6 KVA	208 volts
Power, 350 Console	3.8 KVA	208 volts
Power, air conditioner	12.0 KVA	
Volume, computer	380.46 cu ft	
Volume, air conditioner	68.89 cu ft	
Area, computer	142.67 sq ft	
Area, air conditioner	13.77 sq ft	
Floor loading	50 lbs/sq ft	
Capacity, air conditioner	10 Tons	
Weight, computer	8,432 lbs, all components	
Weight, air conditioner	1,510 lbs	

The room where the RAMAC is located is a partitioned, fireproofed division of a cement vault and provides

800 square feet of office space. The allowable temperature variation is from 50° to 90° with humidity not exceeding 80%.

Ford Motor Canton

Power, computer 22,000 Kw	25 KVA 220V 3 phase
Volume, computer	8,640 cu ft
Area, computer	7,200 sq ft
Room size, computer	28 ft x 42 ft
Floor loading	1.3 lbs/sq ft
	100.0 lbs concen max
Capacity, air conditioner	6 Tons Central System
Weight, computer	9,000 lbs

Electrical distributions, exhaust system and necessary fire preventive system.

Ford Wayne

Power, computer 28.8 Kw	15.1 KVA
Power, air condit 2.3 Kw	47.3 KVA
Volume, computer	400 cu ft
Volume, air conditioner	66.9 cu ft
Area, computer	86 sq ft
Area, air conditioner	20 sq ft
Room size, comp & air cond	15 ft x 30 ft
Floor loading	50 lbs/sq ft
	2,140 lbs concen max
Capacity, air conditioner	8 Tons
Weight, computer	8,925 lbs
Weight, air conditioner	1,050 lbs

SUNOCO Philadelphia

Power, computer	15 KVA
Volume, computer	4,000 cu ft
Volume, air conditioner	140 cu ft
Area, computer	400 sq ft
Area, air conditioner	20 sq ft
Room size, computer	24 ft x 42 ft
Capacity, air conditioner	12 Tons
Weight	Lbs.
Key Punch	204
Key Punch	208
Key Punch	208
Verifier	222
Sorters	492
Collator	840 approx.
Reproducing	1,289
Tab-off-line	3,286
Tab-on-line	3,286+
Interpreter	770 approx.
RAMAC-Console	1,015
Desk Unit	2,140
Process Unit	1,945
Power	1,810
Punch (RAMAC)	760

Site preparation included sound absorbent tile on walls, air conditioning added, and power lines added with floor outlets.

SUNOCO Southland Center

Power, computer 9.339 Kw	16.4 KVA 0.57 pf
Volume, computer	3,200 cu ft
Volume, air conditioner	248 cu ft
Area, computer	400 sq ft
Area, air conditioner	31 sq ft
Floor loading	50 lbs/sq ft
	100 lbs concen max
Capacity, air conditioner	7 1/2 Tons
Weight, computer	8,925 lbs
Weight, air conditioner	750 lbs

Site preparation included electric outlets, supplemental air conditioning, and heat discharge plenums.

WE Aurora

Power, computer 11.8 Kw	15.1 KVA 0.80 pf 208V
Volume, computer	3,888 cu ft
Area, computer	432 sq ft
Room size, computer	18 ft 1 in x 20 ft 4 in
Floor loading	50 lbs/sq ft
	150 lbs concen max
Weight, computer	8,925 lbs.

Site preparation included glass and wall partitioning, and air conditioning controls in room itself.

WE GPC New York

Power, computer	12.6 KVA
Volume, computer	1,925 cu ft
Area, computer	385 sq ft
Room size	Large room w/other equipment
Floor loading	100 lbs/sq ft
	200 lbs concen max
Weight, computer	11,189 lbs

Computer will be located in building now under construction - additional power and floor loading provided during construction.

WE TSD New York

Power, computer	15.7 KVA
Power, air cond	19.4 Overhead units
(Two GE No. FCA-50)	
Volume, computer	430.9 cu ft
Volume, air conditioner	210 cu ft
Area, computer	92.4 sq ft
Room size, computer	24 ft x 28 ft
Floor loading	150 lbs/sq ft
	1,362 lbs concen max
Capacity, air conditioner	10 Tons
Weight, computer	9,370 lbs
Weight, air conditioner	3,000 lbs

The computer is presently installed in leased space. A move to our new building is expected in about 6 months. The two air conditioning units of 5 tons capacity each, are suspended from the ceiling. A temporary wooden ramp has been provided to protect the exposed cables connecting the machines. A feeder cable was installed from the ground to the fourth floor.

WE Winston-Salem

Power, computer 38.3 Kw	15 KVA
Power, air conditioner	25 KVA
Volume, computer	402.6 cu ft
Volume, air conditioner	14,400 cu ft
Area, computer	84.1 sq ft
Area, air conditioner	1,200 sq ft
Floor loading	164.5 lbs/sq ft
	631 lbs concen max
Capacity, air conditioner	12 Tons
Weight, computer	13,835 lbs

Building perimeter heating removed and insulated sound deadening wall installed. Air handling unit utilizing existing steam and chilled water installed. Extensive rearrangement of personnel and electrical telephone facilities to provide the necessary space. Special plenums constructed over power units for heat outtake.

Georgia State

Power, computer 9.34 Kw	16.4 KVA 0.57 pf
Volume, computer	534 cu ft
Area, computer	161 sq ft
Room size, computer	17 ft x 21 ft
Floor loading	52.4 lbs/sq ft
Weight, computer	8,432 lbs

Installed in existing building modified only to the extent of partitioning the area so that the computer itself occupies a separate room. Two 100 ampere circuits for system and exhaust head with 3,000 cu ft/min fan installed.

PRODUCTION RECORD

Manufacturer
Time required for delivery 8 months

COST, PRICE AND RENTAL RATES

Manufacturer
Basic System

305	Processing unit	$189,950, or 3,200/month and
350	Disk Storage unit	up, (printed output)
370	Printer	
323	Card Punch	$167,850, or 2,875/month and
380	Console	up, (punched card output)
340	Power Supply	

Details available on request.

USA LOD

$12,297 basic prime shift rental per month.

USA Medical Depot

305 Processing Unit
323 Card Punch
340 Power Supply
350 Disk Storage
380 Console
407 Printer

Total Monthly Rental Cost: $4,510/month

Additional Equipment

3 024 Card Punches
3 056 Card Verifiers
2 083 Sorters
1 077 Collator
1 088 Collator
2 519 Document Originating Machines
1 557 Interpreter
2 407 Accounting Machines

Total Monthly Rental Cost: $3,273/month

USA Mt Rainier Ord D

Basic System

Each system $4,000/month.

Additional Equipment

Each system $2,472/month.

USA Raritan

Lot No. 1 Basic System No. 1819

	Model	Type	Unit Price per Month	Amount/ Month
RAMAC Processing Unit	1	305	$1,250	$1,250
Card Punch	1	323	225	225
Card Punch	1	323	225	225
Disk Storage	14	350	1,600	1,600
Console	1	380	400	400
Power Unit	1	340	325	325
				$4,025

Lot No. 1 Additional Equipment System No. 1819

	Model	Unit Price per Month	Amount/ Month
Addn Char Sel Pos	128	$ 2	$ 2
Addn Cycle Delay Units	244	10	10
Char Sel 1 Grp of 6 Spl Pos	130	5	5
Addn Latch Selectors	722	10	30
Addn Gp Dbl Dist	284	8	8
Addn Process Tracks	610	10	20
Prog Entry Isolation	613	25	25
Program Exit Split	614	15	15
Printer Output Track	607	5	5
Disk Storage Control (Model 14)	282	80	80
2nd Addn Gp Dbl Dist RPQ E90172		10	20
5 Addn Compg Pos, RPQ E90165		5	10
Character Sel Split, RPQ E90163		15	30
W/P Cycle Overlap, RPQ E90164		25	25
Latch Selectors, RPQ E90174		10	20
Single Dist 41 to 80, RPQ E90171		18	18
323 T Track, RPQ M86989		115	115
5 Blank Trans Sel Pos, RPQ 79638		5	10
Simult Rec Adv Pgm Adv, RPQ W86833		30	30
Tracks $ and *, RPQ E94512		17	17
Dbl Punch Blank Col Detect	300	8	48
Grp 4 Five Pos Co Selectors	705	5	25
Digit Selector	275	5	5
Group 5 Two Pos Pilot Select	703	10	20
Digit Selector	275	5	5
Group 5 Two Pos Pilot Select	703	10	20
Dbl Punch Blank Col Detect	300	8	48
Grp 4 Five Pos Co Selectors	705	5	25
Dual Access, RPQ M90487		850	850
Auto Address Conv, RPQ E90170		35	35
Aux Card Counter, RPQ E90162		15	15
			$1,571

Lot No. 2, Basic System No. 1820

	Model	Type	Unit Price per Month	Amount/ Month
RAMAC Processing Unit	1	305	$1,250	$1,250
Card Punch	1	323	225	225
Card Punch	1	323	225	225
Disk Storage	13	350	1,550	1,550
Console	1	380	400	400
Power Unit	1	340	325	325
			Total	$3,975

Lot No. 2, Additional Equipment System No. 1820

	Model	Unit Price per Month	Amount/ Month
Addn Char Sel Pos	128	$ 2	$ 2
Addn Cycle Delay Units	244	10	10
Char Sel 1 Grp of 6 Spl Pos	130	5	5
Addn Latch Selectros	722	10	30
Addn Gp Dbl Dist	284	8	8
Addn Process Tracks	610	10	20
Prog Entry Isolation	613	25	25
Program Exit Split	614	15	15
Printer Output Track	607	5	5
2nd Addn Gp Dbl Dist, RPQ E 90172		10	20
5 Addn Compg Pos, RPQ E90165		5	10
Character Sel Split, RPQ E90163		15	30
W/P Cycle Overlap, RPQ E90164		25	25
Latch Selectors, RPQ E90174		10	20
Single Dist 41 to 80, RPQ E90171		18	18
323 T Track, RPQ M86989		115	115
5 Blank Trans Sel Pos, RPQ 79638		5	10
Simult Rec Adv Pgm Adv, RPQ W86833		30	30
Tracks $ and *, RPQ E94512		17	17
Dbl Punch Blank Col Detect	300	8	48
Grp 4 Five Pos Co Selectors	705	5	25
Digit Selector	275	5	5
Group 5 Two Pos Pilot Selec	703	10	20
Digit Selector	275	5	5
Grp 5 Two Pos Pilot Select	703	10	20
Dbl Punch Blank Col Select	300	8	48
Grp 4 Five Pos Co Selectors	705	5	25
Dual Access, RPQ M90487 (E93455)		850	850
Auto Address Conv, RPQ E90168		35	35
Aux Card Counter, RPQ E90162		15	15
		Total	$1,531

USA Red River Arsenal

Type/Model or Device Code	RPQ#	Description	Qty	Unit Price	Total Rental
Basic Equipment for Red River Arsenal					
305 1		Processing Units	2	$ 1250	$ 2500
323 1		Card Punches	2	225	450
323 2		Card Punches	2	225	450
607		T Tracks	2	5	10
273511	M86989	323 on T Track	2	115	230
340 1		Power Units	2	325	650
350 13		Disk Storage	1	1550	1550
350 14		Disk Storage	1	1600	1600
350 14		Disk Storage (Third File)	1	1600	1600
282		Disk Storage Control	1	80	80
272781	W88425	Disk Storage Control (Third File)	1	115	115
380 1		Consoles	2	400	800
		Dual Systems Control	-	Included in Disk Storage price	
	M90487	Dual Access Arms for Model 13	1	850	850
	M90487	Dual Access Arms for Model 14	1	850	850
	M90487	Dual Access Arms for Model 14 (Third File)	1	850	850
Special Devices					
Type 305 Computer					
263601	79275	Automatic Inquiry Address Conversion	2	$ 35	$ 70
128		Character Selectors - 3 Additional Positions	2	2	4
244		Cycle Delays - 1 Group - 15 Additional	2	10	20
130		Character Selectors - 1 Group of 6 Special Positions X-No X, 0-No 0	2	5	10
722		Latch Selectors - 3 Groups - 10 @ $10 per group	2	30	60
276401	73009	Latch Selectors - 2 Groups @ $10 per group	2	$ 20	$ 40
284		Double Distributors - 1 Group of 20	2	8	16
270801	77106	Double Distributors - 2 Groups of 20 @ $10	2	20	40
271601	77105	Single Distributors - 2 Groups of 20 @ $9	2	18	36
610		Processing Tracks - 4 Additional (2 Groups @ $10)	2	20	40
614		Program Exit Splits	2	15	30
613		Program Entry Isolation	2	25	50
266401	79639	Comparing Units - 10 Additional Positions @ $5 per group of 5	2	10	20
275001	85259	Exit Cycle - To cycle overlap	2	25	50
277201	81468	Character Selector Splits	2	30	60
265601	79638	Blank Transmission Selectors - 2 Additional Groups @ $5 per group of 5	2	10	20
	82365	Erase on Transfer	2	10	20
277001	W86833	Simultaneous Impulse of Record Advance and Program Advance	2	30	60
	W90592	W X Processing Tracks	2	25	50
	W90592	Y Z Processing Tracks	2	25	50
	W90592	/ U Processing Tracks	2	25	50
	W90592	$ * Working Storage Tracks	2	17	34
Type 323 Card Punch					
300		60 Additional DPBC @ $8 each 10	4	48	192
703		2 Groups 5-2 Position Pilot Selectors @ $10 per group	4	20	80
705		5 Groups 4-5 Position Co-Selectors @ $5 per group	4	25	100
275		Digit Selectors	4	5	20
		TOTAL RENTAL			$ 13,807

USN CNS

Rental Rates for Basic System

Machine Name	Monthly Rental
305 Processing Unit	$1,726.00
323 Card Punch	270.00
340 Power Unit	325.00
350 Disk Storage, Mdl 11	1,050.00
350 Disk Storage, Mdl 12	1,100.00
407 Printer	1,042.50
380 Console	495.00

Rental Rates for Additional Equipment

381 Remote Inquiry Station	208.00
1926 Remote Inquiry Station	250.00

Maintenance service included in rental contract.

Hamilton AFB

Actual Cost per month.

Component	Basic Use Charge	Basic Use
305 Processing Unit	$1,564	176 Hrs.
323 Card Punch	333	176 Hrs.
340 Power Supply	325	176 Hrs.
350 Disk Storage	650	176 Hrs.
350 Disk Storage	700	176 Hrs.
370 Printer	360	176 Hrs.
380 Console	400	176 Hrs.
	$4,332	

NOTE: Extra use charges average slightly over $2,000 per month for a total rental of $6,332 per month.

026 Printing Card Punch
056 Verifier
082 Sorter
089 Collator
407 Accounting Machine
519 Originating Machine
552 Interpreter

Machines are used jointly with Statistical Services, a total of $1,442 per month is for supply use only.

Offutt AFB

The 305 Processing Unit, 323 Card Punch, 340 Power Unit, 350 Disk Storage, 370 Printer, 380 Console, cost $199,550 and rents at $3,600/month.

The additional equipment cost $18,418 and rents at $443/month. Maintenance cost $494.75/month.

The additional equipment consists of:

2 Gps of 5 Addn Comparing Positions
2 Gps of 2 Addn Work Processing Tracks
2 Gps of Addn 20 Single Position Distributors
3 Gps of 20 Addn Double Distributors
4 Gps of 10 Addn Double Position Latch Selectors
1 Gp of 3 Addn Character Selectors
1 Gp of 15 Addn Cycle Delays
1 Program Exist Split
1 X No X Bit and Zero no Zero Bit Selectors
2 Gps of 5 Addn Blank Transmission Selectors
1 Character Selector Split
1 Division
1 Program Entry Isolation
1 Multiple Record Transfer
1 Checking Multiple Record Transfer
1 Compare Search
2 Gps of 5 Two Pos Pilot Selectors
1 Gp of 4 Five Pos Co Selectors
3 Gps of 10 Double Punch
1 Cipher to Replace Numeric Zero

USAF Richards-Gebaur AFB

IBM 305, 340, 380, 323, 350, and 370 rents at $50,910 per year.

Boeing, Wichita

Basic System

305 Processing Unit		$74,270
340 Power Unit		24,700
380 Console		28,400
	Total	$127,370

Additional Equipment

323 Card Punch		$12,580
350 Disk Storage		34,500
370 Printer		22,100
	Total	$69,180

System is not purchased.

Basic System Hourly Rates

305 Processing Unit	$7.83	$3.13	(off-shift)
340 Power Unit	1.85	.74	(off-shift)
380 Console	2.27	.91	(off-shift)

Additional Equipment Hourly Rates

323 Card Punch	$1.31	$ .52	(off-shift)
350 Disk Storage	3.69	1.48	(off-shift)
370 Printer	1.99	.80	(off-shift)

Ford Motor

Basic System

$4,800 monthly contract, 176 hours/month.

Additional Equipment

$1,600 monthly contract, 176 hours/month.

Ford, Wayne

Basic system $3,900 per month, including Type 370 Printer, 323 Punch, 305 Process Unit, and 380 Type-writer and Reader.

Additional Equipment

Type 407 Accounting Machine	$1,135 per month
Type 523 Summary Punch	85 per month.

SUNOCO Philadelphia

1	024	Key Punch	$ 40.00
1	026	Key Punch	60.00
1	026	Key Punch	63.00
1	056	Verifier	50.00
2	082	Sorters	55.00 ea.
1	085	Collator	125.00
1	514	Reproducing	149.00
1	407	Tab-off-line	835.00
1	407	Tab-on-line	1,067.50
1	548	Interpreter	100.00
1	380	RAMAC-Console	400.00
1	350	Desk Unit	1,050.00
1	305	Process Unit	1,555.00
1	340	Power	325.00
1	323	Punch (RAMAC)	245.00
		Excise Tax	596.00
		Penna. Sales Tax	270.82
		Total	$7,041.32

SUNOCO Southland Center

Basic System

305 Processing Unit, 323 Card Punch, 340 Power Supply, 350 Disk Storage, 370 Printer, and 380 Console rents at $3,833/month.

Additional Equipment

083 Sorter, 077 Collator, 407 Printer, and 514 Summary Punch rents at $1,432/month.

WE Aurora

Basic System	Per Month
305 Processing Unit	$1,250
323 Card Punch	225
350 Disc Storage Unit	650
340 Power Supply	325
380 Console	400
370 Printer	350
	$3,200

Additional Equipment

284	(20) Double Distributor	$ 8
609	Printer Output Track	5
610	Additional Processing Track	10
613	Program Isolation	25
722	Additional Selectors	10
614	Split Program Exits	15
128	Additional Character Selectors	2
	Additional Blank Transmission	5
		$80

Plus 10% Federal excise tax.

WE GPC New York

305, 340, 380, 370, 232, and 407 rents at $70,250 per year.

WE TSD New York

The 305 Process Unit, 350 File Unit, 380 Console, 340 Power Unit, and 323 Card Punch rent at $3,554 per month plus 13% tax.

The 797 Reader Punch rents at $1,100 per month, plus 13% tax.

WE Winston-Salem

The IBM 305, IBM 323, IBM 340, IBM 350, IBM 407 (on line), and IBM 380 rent at $7,018.

The IBM 085 (2), IBM 558, IBM 514 (2), IBM 407, IBM 083, IBM 024 (2), and IBM 056 (2) rent at $957 monthly.

Georgia State

Type	Description	Monthly Rental Cost
305	RAMAC	$1,250
289	Direct Division Device	45
323	Card Punch	225
340	Power Supply	325
350	Disk Storage	650
370	Printer	350
380	Console	400
	Additional Equipment	
402	Accounting Machine	195
514	Reproducing Punch	70
026	Printing Card Punch	60
082	Sorter	40

Monthly rates less 60%.

PERSONNEL REQUIREMENTS

Manufacturer

Number of people needed to define and develop a program depends on complexity of application. However, once programmed and running, one operator per shift can handle feeding of cards and removal of printed reports.

Training made available at Educational Centers and local branch offices in principal cities.

USA LOD

	One 8-Hour Shift
Supervisors	3
Programmers	7
Operators	3

Three additional operators are required for each additional 8 hour shift.

Analyst functions performed by programmers at present time as a means of developing analysts.

Data Processing Activity is to be reorganized to conform with needs as developed through actual operations.

Operation tends toward open shop.

3 weeks formal training furnished by contractor. 23 weeks on-the-job training.

USA Medical Depot

	Three 8-Hour Shifts Used	Three 8-Hour Shifts Recommended
Supervisors	7	7
Programmers	2	2
Coders	2	2
Clerks	3	3
Operators	10	10
Engineers	1	1
In-Output Oper	1	1

Methods of training used includes IBM Customer Education Program and on-the-job training.

Louisville Medical Depot utilizes an integrated system of RAMAC 305 and conventional IBM electrical accounting machines. All major program applications are dependent on the availability of both types of equipment. Two (2) personnel only are assigned full time to operation of the RAMAC 305 and these are included in the figures. All other personnel are involved in operations as they pertain to RAMAC 305 and/or conventional electrical accounting machines. The engineer is furnished by IBM at no charge.

USA Mt Rainier Ord D

	One 8-Hour Shift Used	One 8-Hour Shift Recomm	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recomm
Supervisors	2	2	2	2
Analysts	1	2		
Programmers	4	5		
Clerks	1	1		
Librarians	1	1		
Operators	2	3	2	3
Engineers	1	IBM Corp		
In-Output Oper	2	2	2	

Programmers and console operators are women, very capable.

Methods of training used includes aptitude tests, schooling three (3) weeks under direction of IBM, additional six (6) weeks on special features, and one (1) year on-the-job for productive programming, coding and control panel wiring.

USA Raritan

	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recommended
Supervisors	4	4
Analysts	5	5
Programmers	3	3
Clerks	2	2
Operators	4	4
In-Output Oper	2	2

Coding is an integral part of programming, therefore, coders are not shown as a personnel requirement.

Engineers and technicians are supplied by the manufacturer as required.

Tape handlers are not required with this equipment.

Operation tends toward open shop.

Methods of training used includes manufacturer's schools, on-the-job training, and government sponsored schools.

USA Red River Arsenal

	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recommended
Supervisors	3	3
Programmers	10	10
Clerks	1	1
Operators	8	8
Engineers	2	2

Methods of training used includes class room and on-the-job training for programmers, operators, analysts, and key personnel of application.

USN CNS

	Two 8-Hour Shifts Used	Recommended
Supervisors	1	1
Analysts	2	2
Programmers	4	4
Operators	3	3

Methods of training include manufacturer's training courses and on-the-job training.

Hamilton AFB

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Programmers	2	2
Coders	3	3
Clerks	7	7
Engineers	On call when operating	
In-Output Oper	2	2

Clerks are key punch operators (4) and input and output (3) clerks.

Customer Service Engineer is on call when operating. A full second 8-hour shift is not used.

Operation tends toward open shop.

Methods of training used includes formal on-the-job (OJT) and formal classroom when required by program or system changes.

Offutt AFB

	First 8-Hour Shift U	R	Second 8-Hour Shift U	R	Third 8-Hour Shift U	R
Supervisor	1	1	1	1	1	1
Coders	3	3	2	2	1	1
Librarian	1	1	1	1	1	1
Operator	2	2	1	1	1	1
Engineers		Contractor Personnel on call				
Technician		Contractor Personnel on call				

EDP program within SAC is controlled by the EDP Development Group assigned by SAC Hq. All programmers for supply application of EDP within SAC are assigned to this Development Group. No programmers are assigned base level. Engineers and techs are on call 24 hours a day from contractor service.

Methods of training includes 8 week formal classroom training for console supervisors and operators. 2 week course for high level supervisors and managers. No directed on-the-job training.

USAF Richards-Gebaur AFB

	One 8-Hour Shift Used	Recommended
Supervisors	1	
Programmers	2	3
Coders	2	3
Operators	3	3
In-Output Oper	4	4

Operation tends toward open shop.

Methods of training used includes on-the-job training and IBM school.

Boeing, Wichita

	First 8-Hour Shift U	R	Second 8-Hour Shift U	R	Third 8-Hour Shift U	R
Supervisor					1	
Programmer	4					
Operator					3	
In-Output Oper			2			

Six keypunch operators prepare the input cards from source documents. Up to 22 different transactions are handled in a normal day's processing.

Operation tends toward closed shop.

Methods of training used includes IBM schools and on-the-job training.

Ford Motor Canton

	First 8-Hour Shift	Second 8-Hour Shift	Third 8-Hour Shift
Supervisors	1		
Analysts	1		
Programmers	1		
Coders	2	2	1
Clerks	2		
Librarians	1		
Operators	2	1	

Operation tends toward open shop.

Methods of training used includes International Business Machine Corporation specialized training and local programs.

Ford, Wayne

	One 8-Hour Shift Used	Recomm	Two 8-Hour Shifts Used	Recomm
Supervisors	1	1		
Programmers	2	2		
Coders	2	2		
Operators	1	1	1	1

Operation tends toward open shop.

Methods of training used includes IBM Specialized School.

SUNOCO Philadelphia

	One 8-Hour Shift
Supervisors	1
Operators	2

4 analyst-programmers prepared original system and program. They are not part of the department operating RAMAC.

Operation tends toward closed shop.

Methods of training used includes a 2 week IBM school and on-the-job instruction.

SUNOCO Southland Center

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts	1	2
Programmers	1	2
Clerks	1	1
Operators	1	1

Operation tends toward open shop.

Methods of training used includes Equipment Supplier Schools and on-the-job training.

We only contemplate single shift operations at this time.

WE Aurora

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	1
Operators	1

Operation tends toward open shop.

Methods of training used includes selected employees with previous EAM experience and/or aptitude, attendance at IBM Educational Centers, and extended de-bugging recording of common errors.

Views may change. Above based on four months of "machine" experience.

WE GPC New York

	One 8-Hour Shift
Supervisors	1
Analysts	2
Programmers	1
Clerks	16
Operators	2

Methods of training used includes IBM schools and two week class conducted by supervisor.

WE TSD New York

	One 8-Hour Shift
Supervisors	2
Analysts	5
Programmers	8
Operators	2

The computer is normally used on a single shift basis. The size of the staff is due to the high percentage of development work done on the computer.
Operation tends toward open shop.
Methods of training used includes staff training program (learn Distributing House Operation). Time required is up to one year. IBM Program School for 305 RAMAC is two weeks. Apprentice period is from 6 months to a year.

WE Winston-Salem

	One 8-Hour Shift
Supervisors	1
Analysts	2
Programmers	3
Operators	1
In-Output Oper	5

Methods of training used includes manufacturer's school and on-the-job training.

Georgia State

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Programmers	1	2
Clerks	1	1
Operators	0	1

Operation tends toward closed shop.
Methods of training used includes IBM schools and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

System features and construction techniques utilized by the manufacturer to insure required reliability includes internal machine checking for correct character transfers. Arms retract during data alterations, disk heads float on air and lift off surface with power failure, designed to operate correctly with marginal voltage, selected components, final testing during manufacturing, and by customer engineers. Availability is better than 85% average for installed systems.

USA LOD

Passed Customer Acceptance Test 15 Jun 60
Time is not available for rent to outside organizations.

USA Medical Depot

Good time 34.5 Hours/Week (Average)
Attempted to run time 35 Hours/Week (Average)
Operating ratio (Good/Attempted to tun time) 0.98
Above figures based on period 1 Jul 59 to 31 Mar 60
Passed Customer Acceptance Test Apr 58
Time is not available for rent to outside organizations.
System has operated without mechanical error during the period on which figures are based.

USA Mt Rainier Ord D

Average error-free running period Fair during 1st two weeks
Good time 60 Hours/Week (Average)
Attempted to run time 60 Hours/Week (Average)
Operating ratio Good after five weeks in operation
Above figures based on period 27 Jun 60 to 5 Aug 60
Passed Customer Acceptance Test 24 May 60
Time is not available for rent to outside organization

After six (6) weeks of operation programmers and off-line operational errors were decreasing, likewise machine down time and errors due to machine.

USA Raritan

Good time 59 Hours/Week (Average)
Attempted to run time 70 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.84
Above figures based on period 23 Mar 60 to 5 Apr 60
Passed Customer Acceptance Test 5 Apr 60
Time is available for rent to qualified outside organizations.
The above time is based on a 16 hour shift because two computers are involved. They are tied together with dual control, dual access devices making one system.
The period designated is for the standard of performance GSA contract.

Latest information on reliability, operating experience and time availability:
Good time 209 Hours/Week (Average)
Attempted to run time 255 Hours/Week (Average)
Operating ratio 0.82
Above figures based on period 1 Apr 60 to 30 Apr 60
The above information is based on two computers scheduled for 24 hours during the testing and debugging, file load and conversion period. No operational experience to date.

USA Red River Arsenal

Good time 147 Hours/Week (Average)
Attempted to run time 157 Hours/Week (Average)
Operating ratio 0.936
Above figures based on period 1 Mar 60 to 31 Mar 60
Passed Customer Acceptance Test 29 Feb 60
Time is not available for rent to outside organizations.

USN CNS

Average error-free running period 20 Hours
Good time 112 Hours/Week (Average)
Attempted to run time 118 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period 1 Jan 60 to 30 Jun 60
Time is not available for rent to outside organizations.
Original machine with 5,000,000 characters of random access storage was installed February 1958. Storage was expanded to 10,000,000 characters in November 1958.
In March 1960 a new, double density machine with 20,000,000 characters random access storage was installed and accepted to replace original equipment.

Hamilton AFB

Average error-free running period No average error-free period known. Machine is so reliable that it will not make any errors for weeks at time and then one or two errors could happen at any time.
Good time 95 Hours/Week (Average)
Attempted to run time 102 Hours/Week (Average)
Operating ratio 0.93
Above figures based on period from Jul 59 to Apr 60
Passed Customer Acceptance Test Feb 58
Time is not available for rent to outside organizations.

Offutt AFB

Good time 72 Hours/Week (Average)
Attempted to run time 78 Hours/Week (Average)
Operating ratio 0.927
Above figures based on period 1 Jan 60 to 31 Jan 60
Passed Customer Acceptance Test May 58
Time is not available for rent to outside organizations.

USAF Richards-Gebaur AFB

Average error-free running period 48 Hours
Good time 48 Hours/Week (Average)
Attempted to run time 48 Hours/Week (Average)
Operating ratio 1.0
Above figures based on period 1 Feb 60 to 30 Apr 60
Time is not available for rent to outside organizations.

Boeing, Wichita

Average error-free running period 28.18
Good time 121.20 Hours/Week (Average)
Attempted to run time 139.43 Hours/Week (Average)
Operating ratio 0.8693
Above figures based on period 1 Mar 60 to 31 Mar 60
Passed Customer Acceptance Test 10 Jun 58
Time is not available for rent to outside organizations.

Ford Motor Canton

Average error-free running period 72 Hours
Good time 37 Hours/Week (Average)
Attempted to run time 42 Hours/Week (Average)
Operating ratio 0.88
Above figures based on period 4:00 am Monday to 8:00 am Saturday
Passed Customer Acceptance Test 1 Oct 59
Time is not available for rent to outside organizations.

Ford, Wayne

Good time 50 Hours/Week (Average)
Attempted to run time 52 Hours/Week (Average)
Operating ratio 0.96
Above figures based on period 15 Mar 60 to 15 Apr 60
Passed Customer Acceptance Test Nov 59

SUNOCO Philadelphia

Good time 40 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 1.0
Above figures based on period 1 Jul 60 to 26 Aug 60
Passed Customer Acceptance Test Nov 59
Time is not available for rent to outside organizations.

WE Aurora

Good time 12 Hours/Week (Average)
Attempted to run time 12.25 Hours/Week (Average)
Operating ratio 0.979
Above figures based on period 1 May 60 to 31 Jul 60
Passed Customer Acceptance Test 1 May 60
Time is not available for rent to outside organizations.

Reliability of above figures may be questionable. Machine experience limited to eleven weeks of "on hands" operation.

WE TSD New York

Operating ratio 0.91
Above figure based on period 16 Jun 59 to 30 Jun 60
Time is not available for rent to outside organizations.

WE Winston-Salem

Good time 46 Hours/Week (Average)
Attempted to run time 51 Hours/Week (Average)
Operating ratio 0.903
Above figures based on period from Jun 60 to present
Passed Customer Acceptance Test Mar 52
Time is not available for rent to outside organizations.

Georgia State

Good time 37 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.925
Above figures based on period 1 Jun 60 to 30 Jun 60
Passed Customer Acceptance Test 1 Jan 60
Time is available for rent to qualified outside organizations.

As a new installation dedicated to education, our current policy restricts use of the machine to teaching and research. This policy is subject to change.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features includes random access to large capacity disk storage of up to 20 million alphanumeric characters, variable record length, and stored program coupled with control panel logic.

Unique system advantages include the ability to process data in-line as transactions occur and maintain current records for examination by inquiry at any time.

Procedures for magnetic tape labelling, storing, shipping, and protection from humidity, temperature, electrical, fire, or other damage are the same as for 700-7000 Systems using magnetic tape.

Many special features have been engineered to make RAMAC a flexible machine for in-line processing. It can be tailored to all applications as a result.

USA LOD

Outstanding features include compatibility with present punch card applications and random access.

Acquisition of IBM 305 RAMAC Systems for Ordnance distribution depots is identified as an interim program. If so, it is a unique method of transition from basic punch card concepts to more sophisticated equipment which enable installations to grow into it rather than experience the turmoil that usually accompanies the installation of radically new systems.

USA Medical Depot

Outstanding features include faster, more accurate reporting; provides up-to-the-minute supply control data on stocked items as required, provides for considerable expansion without the need for additional personnel or equipment. Provides complete flexibility of operations.

USA Mt Rainier Ord D

Outstanding features include storage of records, quick access, self checking accurate output, faster access time, accurate record keeping, and accurate processing of input.

Humidity and temperature control according to specifications are provided for magnetic tape.

Configuration of Equipment

340	305	Compressor	380	Compressor	380	340	305
323							323
323			350 Master	350 Slave			323

305 Processing Unit
350 Disk Storage Unit
380 Console
340 Power Unit
323 Card Punch

USA Raritan

Outstanding features are random access machine, stock transactions and financial inventory accounting updated concurrently, and system permits immediate inquiries of data held in bulk storage files.

IBM RAMAC 305 System Configuration

Overall System

Two identical IBM RAMAC 305 Processing Units are interconnected through the Dual Processing Feature.

Two Double Density RAMAC Disk Storage Files are accessible to each Processing Unit for a total file capacity of 20,000,000 alphanumeric characters in 200,000 spearately addressable locations.

Two access arms are available to each Processing Unit for addressing each RAMAC file. Thus, each RAMAC file unit contains four access arms.

Two IBM 323 Card Punch Units are attached to each Processing Unit instead of the usual combination of one 323 Card Punch and one 370 Printer.

Drum Tracks

Stored Program or Processing (20 tracks): 0 through 9 and A through I

Processing (10 tracks):
W X Y Z U / . # $ *

Input, Output, or Processing (4 tracks): K S T Q

One 323 Card Punch on each 305 will be associated with the "S" output track and the other, with the "T" output track.

Accumulator Track (addressable as L or M)

Multiplicand Track (addressable as V)

Process Control Panel Features

Split Program Exists feature has control hubs at co-ordinate C, 23-26.

Dual Processing Interlock Suspend hubs are located at co-ordinates A, 37-38.

Dual access control hubs are located at C, 27-31.

Character Selectors:
Number 1 (48 exits)
Numbers 2-13 . (13 exits each)
Special X, No-X (3 test positions)
Special 0, No-0 (3 test positions)

Comparing Units: 20 (Total)

Blank Transmission Test Selectors: 15 (Total)

Units Counter. This is a visible counter located within the Process Control Panel enclosure and reset manually. Hubs S, 8-9 labelled "CTR" will accept program exit impulses to cause an advance of 1 in the counter.

Cycle Delays: 30 (Total)

Latch-type selectors (2-position): 60 (Total)

Group A	:	Selectors 1-10
B	:	11-20
C	:	21-30
D	:	31-40
E	:	41-50
F	:	51-60

(NOTE: Each selector group has a corresponding RESET hub.)

Double Distributors: 120 (Total)
40, Numbered 1 through 40
40, Numbered 81 through 120
40, Numbered 121 through 160

Single Distributors: 80 (Total)
40, Numbered 41 through 80
40, Numbered 161 through 200

Automatic Inquiry Address Conversion.

Related hubs are located at AX, 39-40

Program Entry Isolation feature isolates Program Advance hubs as well as Hundreds, Tens, and Units Program Entry hubs.

Differentiating Punches.

The Punch hubs located at co-ordinates AX, 33-36 are associated exclusively with the "S" output track. Those located at AW, 33-36 are associated exclusively with the "T" output track.

Communication with the punch panels.

The Punch Communication hubs located at Y-AF, 1 are associated with the "T"-track punch, and those at Y-AF, 5, with the "S"-track punch.

Other Features on Central Processing Units

Exit Cycle-To-Cycle Overlap ("W/P Overlap")

Simultaneous Record Advance/Program Advance

The Record Advance In-Delayed hub at AH, 3 is associated with this feature. The other two Record Advance in hubs (AH, 1-2) are used for normal record advancing.

323 Card Punch Control Panel

Double Punch-Blank Column Detection: 80 positions (Total)

Pilot Selectors (2-position): 10 (Total)

Co-Selectors (5-position): 20 (Total)

Digit Selectors: 2 (Total)

NOTE: The 323's are not equipped with the Offset Stacking Device.

USA Red River Arsenal

Outstanding features include dual process, double density, extra processing tracks. Unique system advantages include additional plugboard functions, erase on transfer, simultaneous record advance and program advance.

USN CNS

Outstanding features are fast random access to a large colume of stored records, and in-line processing which involves the access, use and updating of several records in one pass rather than several separate, sequential operations.

Hamilton AFB

The outstanding features are that the Processing Section has the ability to read or write in storage unit, transfer information between machine units, compare information and perform arithmetic functions. There is random access to any record. Uses stored program instructions and wired control panel logic. Additional storage units may be added to increase memory capability.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include:

Vibration: withstand vibration up to 0.25G. (G is gravitational acceleration)

Stray Magnetic Field: Stray magnetic field in excess of 50 oersteds will affect the magnetic flux on the disk surfaces.

Temperature and Humidity: Must be maintained between 50 and 90 degrees F. entering the RAMAC unit. The humidity of the air in the RAMAC area must be maintained under 80% relative at all times.

Air Filtration: Normal filtration of the area for dust control can be met with filters that have an efficiency rating of 20% by the National Bureau of Standards discoloration test method.

Offutt AFB

Outstanding features are alphanumeric capability with variable word length up to 100 digits with binary coded decimal character code and random processing of transactions by direct addressing.

USAF Richards-Gebaur AFB

The unique system advantage is the random access memory.

Boeing, Wichita

Outstanding features are that it allows for true random access of any record at an average speed of 600 milliseconds per record and general purpose programming makes possible an in-line system of processing.

A 10-ton all-season air conditioning unit automatically controls humidity and temperature. Hourly inspection by a member of the Fire Marshall's Office during third shift, weekends and holidays is added protection from physical, electrical, fire and other damage.

Ford Motor Canton

Outstanding features are random access to disc storage and limited files - high storage content.

Ford, Wayne

Outstanding features include a large storage capacity, very rapid availability of stored data, and a number of output documents and/or cards obtainable from one input card.

SUNOCO Southland Center

Outstanding features include large capacity random access storage and in-line data processing.

WE Aurora

Outstanding features are disc file, with direct record access.

Disc file is punched into tab cards occasionally as a disaster file.

WE TSD New York

The outstanding features are that the random access magnetic file permits each transaction effecting an item in stock to be processed in line, i.e., as the transaction occurs and the 797 Reader Punch permits punching and punch checking of data in the input card, which saves cards.

Georgia State

Outstanding features are quick access to large storage unit and random access storage.

WE Winston-Salem

Outstanding features are increased processing speeds, 407 on line printer, additional 10,000,000 digits of disk storage, and dual process (two arms).

FUTURE PLANS

USA Medical Depot

Future applications include fiscal accounting, cost accounting (ACMS) and civilian payroll and personnel accounting.

USA Raritan

It is proposed by this installation to install an RCA 501 Computer for two complex and high volume applications, Ordnance Supply Analysis Agency (Statistical Analysis) and Field Service Division (National Inventory Control Point). This is independent of the present installation (IBM 305).

The successful assimilation of logistic requirements by the present computer installation may permit the extension of this system to include some finance and accounting applications, (Ordnance Corps Management System, Stock Fund Accounting) and/or the development of personnel statistics.

Plans are being formulated to improve data collection and data transmission facilities.

USA Red River Arsenal

Plans for the present RAMAC System include addition of tape units for utilization of tape input-output and for possible utilization of Type 1401 equipment to process tape output. Feasibility studies on 1401 equipment have just begun. It is anticipated that RAMAC will be used for several years for availability editing purposes and with tape output for 1401 processing, a completely integrated system will be possible.

USN CNS

Plans for system improvement include increased processing speed through improved programming, output redesigned to use Standard Navy forms, and reduction in clerical/filing areas through redesigned output.

Hamilton AFB

A new program is under development at the present time that will more fully utilize the capabilities of the 305. The new program will contain the following:

Automatic recomputation of stock control levels at re-order point.

In-line special levels computation.

Establishment and management of inviolate levels.

Intra-account transfers and automatic selection of interchangeable items.

Internal inventory accounting monetary (IAM) with assignment of IAM transaction codes and functional expense and general ledger code.

Output of cards for cost distribution.

Output of obligation cards for stock fund and local purchase items.

Self balancing daily transaction register.

Internal stock balance and consumption reports.

In addition, a new 305 will be installed with the latest configuration components that increase processing speed and logic capability.

USAF Richards-Gebaur AFB

It is planned to convert to a new system in accordance with Section 23, Volume II, AFM 67-1.

Boeing, Wichita

We are planning for installation of double density (10,000,000 characters).

WE Aurora

Planned applications include payroll, complete production control of all elements of relay manufacture, departmental and shop summary of payment and accounting results, and production control of commercial screw manufacture.

WE GPC New York

Future plans include performance of linear programs and multiple correlations for forecasting and maintenance of item and price catalogues.

WE TSD New York

An IBM 305 System with 20 million characters of magnetic file storage and the 797 Reader Punch is installed at the Illinois Distributing House in West Chicago, Illinois. This system will replace a standard IBM 305 System operated by the Illinois Bell Telephone Company at the Illinois Distributing House.

The initial application is the preparation of the customers' orders and billing. Approximately half of the volume of the input data will be punched using the Dataphone III system of transmission. The customers supply employee has been equipped with the Dataphone III Card Reader and a set of item cards at his normal work location. To place an order, he telephones the Data Center at the Distributing House, which is equipped with Dataphone III receiving equipment. He feeds the card reader one card at a time, which duplicates this data at the Data Center. Then he keys in the variable data such as the desired quantity which punches variable data in the card at the Data Center. This receiving equipment normally operates unattended. The remaining orders are telephoned to keypunch operators equipped with headsets, are mailed in, or received by teletype.

All phases of material ordering control and customer return material procedures effecting the warehousing, repair shop and the customer are expected to be pro-

cessed through the computer. The emphasis is to establish operational limits which eliminate the necessity for management to review transactions falling within the acceptable limits. A broader objective is to plan the operations of our computers so that the data is available and compatable with data processing equipment in other organizations in the Bell System.

A similar installation with smaller file capacity has been ordered for the Westchester Distributing House in Yonkers, New York.

An in-line printer such as the IBM 407 is desirable on certain applicarions, and is expected to be added to our IBM 305 System.

For the future, a study is underway to determine the feasibility of using an IBM 1401 System equipped with a large random access file.

Georgia State

Future plans call for eventual replacement of existing equipment with an IBM 1620 - 1401 System (or its equivalent), with the possible addition of a Royal McBee LGP 30.

WE Winston-Salem

Computer On Order	Qty	Application	Remarks
IBM 305 RAMAC	1	Production and Storeroom Inventory Control	To be located at Burlington Plant
IBM Card 1401	2	Payroll and Accounting records, Production Control records, Quality Assurance, Apparatus Type Test	To be located in Winston-Salem, and will replace one 650 computer presently installed. Scheduled delivery - Card 1401 - 3rd Qtr. 1961 Card 1401 - 1st Qtr. 1962 Tape 1401 - 2d Qtr. 1962
IBM Card 1401	1	Payroll and Accounting records, Merchandising Spare Parts Documentation, Zeus R & D Production Wiring Layout, Engineering Bill of Materials, and Tool Records	To be located in Burlington Plant. Scheduled delivery - Card 1401 - 1st Qtr. 1962 Tape 1401 - 3rd Qtr. 1962
Monrobot XI (Paper Tape operated with teletype and Flexowriter equipment and Princeton designed data collection devices	1	Job status, delivery performance and load report for each of some 15 operating groups, using in part Operation Research techniques.	To be installed in Printed Circuit Board Department, Greensboro,

Under consideration is one card 1401 computer for Field Engineering and Technical Publication records currently processed on conventional equipment.

INSTALLATIONS

U. S. Army Letterkenny Ordnance Depot
Chambersburg, Pennsylvania

U. S. Army Louisville Medical Depot
Louisville 1, Kentucky

U. S. Army Mt. Rainier Ordnance Depot
Tacoma, Washington

U. S. Army Raritan Arsenal
Metuchen, New Jersey

U. S. Army Red River Arsenal
Texarkana, Texas

U. S. Navy Charleston Shipyard
Charleston, South Carolina

78th Fighter Wing, Base Supply
Hamilton Air Force Base, California

Headquarters, Strategic Air Command
Offutt Air Force Base, Nebraska

328th Fighter Group (Air Defense)
Richards-Gebaur Air Force Base, Missouri

Boeing Airplane Company
Wichita, Kansas

Ford Motor Company
Transmission and Chassis Division
Canton, Ohio

Ford Motor Company
37625 Michigan Avenue
Wayne, Michigan

Sun Oil Company
1608 Walnut Street
Philadelphia 3, Pennsylvania

Sun Oil Company
Southland Center, P. O. Box 2880
Dallas 21, Texas

Western Electric Company, Inc. - Montgomery Shops
Aurora, Illinois

Western Electric Company, Inc.
General Program and Commercial Manager
195 Broadway
New York 7, New York

Western Electric Company, Inc.
Telephone Sales Division
195 Broadway
New York 7, New York

Western Electric Company, Inc.
3300 Lexington Road, S. E.
Winston-Salem, North Carolina

Georgia State College of Business Administration
Computer Center
33 Gilmer Street, S. E.
Atlanta 3, Georgia

Prudential Insurance Company of America
Newark, New Jersey

General Insurance Company of America (Anticipated)
4347 Brooklyn Avenue
Seattle 5, Washington

U. S. Air Force, 327 Fighter Group (Air Defense)
Truax Field, Madison 7, Wisconsin

IBM 604

IBM 604 Electronic Calculating Punch

MANUFACTURER

International Business Machines Corporation

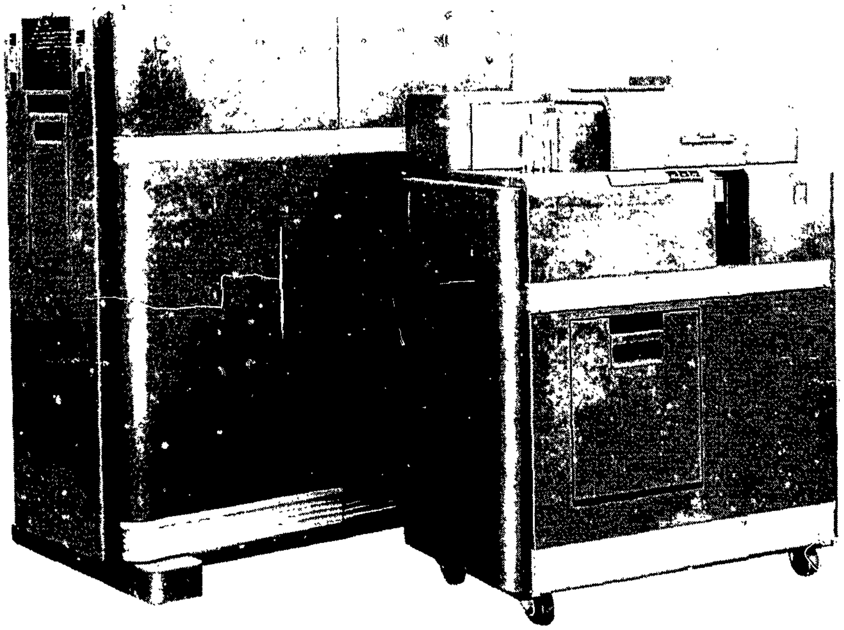


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

Business and scientific.

Management Services Office, White Sands Missile Range, New Mexico

System is used by Comptroller for business-type data processing; civilian payroll, cost accounting, stock accounting, etc.

U. S. Naval Ordnance Test Station, China Lake

Located in Room 1035, the system is primarily used for the calculation of payroll, both civilian and military, also for the calculation of material and labor costs. Because of the flexibility of the machine, it is also used for other tasks such as gang punching, intersperse punching, verification of cards for blank column and double punch tection.

Los Angeles County Engineer

Located at 108 West Second Street, Los Angeles 12, California, the system is used for distribution of costs (Time - Miles - Blueprints) by division, function, job no., etc. Payroll reporting (Mark Sense Cards). Blueprint plant - production and accounting and invoicing. Utilities (water districts) - billing, accounting, stock inventory. Statistics - building and safety, survey parties, industrial waste inspections - overtime, absences, traversing, etc. - error of closure and areas. Geodetic triangulation matrix (simultaneous equations). Street improvement districts: calculating - frontages (estimated and actual assessments, debt limit). Principal and interest on 10-year coupon bonds, unit bids. Printing various notices, name and address lists, envelopes, reports, assessment roll, bills, bonds, bond registers, bond payment notices, sewer location post cards, etc. Capital projects cost distribution and progress reports. Capital outlay and M. & O. (equipment and furniture) inventory. (Sewer design tables) Miscellaneous engineering applications (wind rose for Aviation Div.) (trend line data) etc.

The use of I.B.M. 604 Calculator and 407 Tabulator for computing 10 or 20-year principal and interest payments on street bonds and printing said bonds (with 30 or 60 coupons), a Bond Register and 10 annual Notice of Payments due is a new application, never attempted before, anywhere.

Bankers Life Insurance Company of Nebraska

Located at the Home Office, at Cotner and "O" Streets, Lincoln, Nebraska, the system is used for commission extensions, dividend extensions, premium paid to-up date, premium rate making, dividend schedules, mortality studies (ratios), mortgage loan accounting, policy reserve calculations, and mean reserve schedules.

Harvey Aluminum Sales, Inc., Defense Plants Div.

Located at Milan Arsenal, Building T-1, the system is used for payroll - checks, register, timecards, tax records, etc., accounts payable, cost compilations, direct materials - stock records and reports, general stores (indirect materials) - stock records and reports, plant equipment records, toolroom records,

annual inspection and lot number reports on direct materials, and salvage inventory records.

Manning, Maxwell and Moore, Inc.

Located at 414 Broadway, Muskegon, Michigan, the system is used for payrolls (calculations of wages earned, taxes applicable, net earnings), labor distribution (calculation of labor and burden amounts utilizing master cards), material distribution (calculation of material costs utilizing Master Unit Cost Deck), inventories (calculation of inventories costs utilizing Master Unit Cost Decks), and orders (extending and discounting).

National Airlines, Inc.

Located at the Airport Mail Facility, Miami, Florida, the system is used for payrolls, accounts payable, labor and material cost, accounts receivable, cargo accounting, government transportation billing, revenue statistics, ledger, and sales distribution.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits per word	3 or 5
Instructions used	9
Arithmetic system	Fixed point
Instruction type	One or two address code
Number range	Variable

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	500
Mult	14,000 avg
Div	17,000 avg
Construction	Vacuum tubes
Basic pulse repetition rate	50 Kc/sec
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Medium	Words	Access Microsec
Electronic Tubes	9	500

INPUT

Manufacturer

Medium	Speed
Card Reader-Punch	100 cards/min

OUTPUT

Manufacturer

Medium	Speed
Card Reader-Punch	100 cards/min

LA County

Card speed drops to 25 cards per minute, minimum, for calculating cosine and sine.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	1,250
Tube types	4

CHECKING FEATURES

Checking is possible through control panel wiring.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	7.59 KVA
Volume, computer	73.9 cu ft
Area, computer	19.4 sq ft
Weight, computer	1,949 lbs

WSMR

Power, computer	5.1 Kw	7.59 KVA
Volume, computer		79.9 cu ft
Area, computer		19.4 sq ft
Capacity, air conditioner		5 Tons
Weight, computer		1,949 lbs
Weight, air conditioner		500 lbs

Exhaust fan required.

LA County

Power, computer	230 Volts	19,000 B.T.U.
Power, air conditioner	Exhaust fan 1/8 HP	
Area, computer	24 sq ft	
Weight, computer	2,100 lbs	

Exhaust fan and hood vented to outside through window.

Bankers Life

Power, computer	33.1 Amps	6.9 KVA	0.6 to 0.8 Inductive Load
Volume, computer	53"x33"x58"	58.5 cu ft	
Volume, computer	40"x26"x50"	29.9 cu ft	
Area, computer		20 sq ft	
Room size, computer		12 ft x 12 ft	
Weight, computer		2,041 lbs	

Conventional type building - reinforced concrete floor, central air conditioning with area humidity controlled. Separate power circuit for computer.

Manning, Maxwell & Moore

Power, computer	6.0 Kw	7.5 KVA
Volume, computer		73.9 cu ft
Volume, air conditioner		45.5 cu ft
Area, computer		19.4 sq ft
Area, air conditioner		7.6 sq ft
Floor loading		105 lbs/sq ft
		105 lbs concen max
Capacity, air conditioner		5 Tons
Weight, computer		2,041 lbs

PRODUCTION RECORD

Number produced Over 2,993

Delivery on an availability basis.

COST, PRICE AND RENTAL RATES

Manufacturer

Approximately $550/month and up.

WSMR

604 Electronic Calculator and 521 Card Reader Punch rent at $645/month.

US NOTS

$550 monthly rental rate.

Service time averages 70 hours per month.

LA County

604, 521, and 407 rent at $1,491/month.

407, 2-514's, 2-077's, 083, 082, 552, 5-024's, 2-056's rent at $1,912/month.

Maintenance included in rental.

Bankers Life

604 and 521 cost $26,000.

Rental is $550..

Maintenance/service contract is $153/month.

Manning, Maxwell & Moore

604 Electronic Calculator $430/month (+ 10% excise tax)

521 Card Reader Punch $150/month (+ 10% excise tax)

Service contract contained in rental charges.

National Airlines
3-402, 2-083, 1-552, 6-024, 2-514, 1-604, 2-077 and 2-056 cost $40,000.
Maintenance service is $400/month.

PERSONNEL REQUIREMENTS

WSMR

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	1
Clerks	1
Operators	3

IBM customer courses and local on-post courses are given.

US NOTS

	One 8-Hour Shift
Supervisors	2
Operators	3

Method of training used is on-the-job training.

LA County

	One 8-Hour Shift
Clerks	1
Operators	4
Input Opera	5 6 Recomm

Operation tends toward closed shop (civil service).
Methods of training used include some IBM manuals and machine operation - on job, and evening extension courses.
Chief Tabulating Machine Operator acts as supervisor, analyst, programmer, form designer, systems, and procedure man.

Bankers Life

	One 8-Hour Shift
Supervisors	1
Programmers	1

Methods of training used includes IBM School and on-the-job training.

Manning, Maxwell & Moore

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Operators	1	1

Operation tends toward open shop.
Methods of training used includes on-the-job training supplemented by manufacturer's training schools.

National Airlines

	Two 8-Hour Shifts
Supervisors	2
Operators	17
Technicians	1

Operation tends toward closed shop.
Operators are trained by supervisors.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer
Average service time for all installed machines is approximately 10 hours per month.

WSMR
Good time 14 Hours/Week (Average)
Attempted to run time 16 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period from 1956 to present.
Time is not available for rent to outside organizations.

US NOTS
Time is available for rent to outside organizations.

LA County
Good time 40 Hours/Week (Average)
Attempted to run time 43 Hours/Week (Average)
Passed Customer Acceptance Test 1954
Time is not available for rent to outside organizations.
We do street improvement work for various cities in Los Angeles County.
Employees are assigned different lunch periods, so we often operate equipment more than 8 hours per day.

Bankers Life
Good time 14.4 Hours/Week (Average)
Attempted to run time 15.4 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.935
Above figures based on period 1 Jul 59 to 30 Jun 60
Time is available for rent to qualified outside organizations.

Manning, Maxwell & Moore
Average error-free running period 2 Weeks
Good time 32 Hours/Week (Average)
Attempted to run time 33 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period 1 Jan 57 to 31 Dec 59
Passed Customer Acceptance Test 1 Jan 55
Time is not available for rent to outside organizations.

National Airlines
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
The IBM 604 Electronic Calculator is a general purpose electronic digital computing machine which is helping solve problems in science, engineering, business and government.
Reading problem data from IBM punched cards at a constant speed of 100 problems (cards) a minute, it can go through as many as 60 separate steps, such as multiplications and divisions, to obtain the solution to a single problem. Answers are recorded in the same cards which carry the problem data, or they can be punched in specially designated cards.
The smaller of the two cabinets is the electrical card reading and punching unit. The larger cabinet is the all-electronic unit which includes the following sections: power, timing, arithmetic, storage and switching.
Many built-in features make this electronic calculator easy to operate and service. These include interchangeable control panels for changing from one type of operation to another, and testing devices and pluggable subassemblies which facilitate rapid maintenance and service.
These machines have been produced on the assembly line at IBM's plant in Poughkeepsie, New York, since early 1949.

Bankers Life
Double punch, blank column detection on the 521.

FUTURE PLANS

WSMR
Proposal for Univac Solid State "80" forwarded through command channels.

LA County
Should be able to shift to IBM 1401 (punched card configuration) for costing, utilities, etc. in about 18 months.
Acquisition of an IBM 1620 (with hookup to 1401) would permit complex high speed calculations for engineering - such as traversing, earthworks, calculations (cut and fill), least squares adjustments, etc.
Contemplate use of aperture film cards for maps.

Could then have a complete set of maps in each regional office (surveyor's maps - street no. maps - special district maps - architectural drawings - storm drain maps, etc.)
Bankers Life
IBM Type 1401 Card Input on order.

INSTALLATIONS

Management Services Office
White Sands Missile Range, New Mexico

U. S. Naval Ordnance Test Station, China Lake
China Lake, California

Los Angeles County Engineer
108 West Second Street
Los Angeles 12, California

Bankers Life Insurance Company of Nebraska
Cotner & "O" Streets
Lincoln, Nebraska

Howard Savings Institution
Newark 1, New Jersey

Harvey Aluminum Sales, Inc.
Defense Plants Division
Milan Arsenal
Milan, Tennessee

Manning, Maxwell & Moore, Inc.
414 Broadway
Muskegon, Michigan

National Airlines, Inc.
P. O. Box NAL
Airport Mail Facility
Miami 59, Florida

IBM 607

IBM 607 Electronic Calculator

MANUFACTURER

International Business Machines Corporation

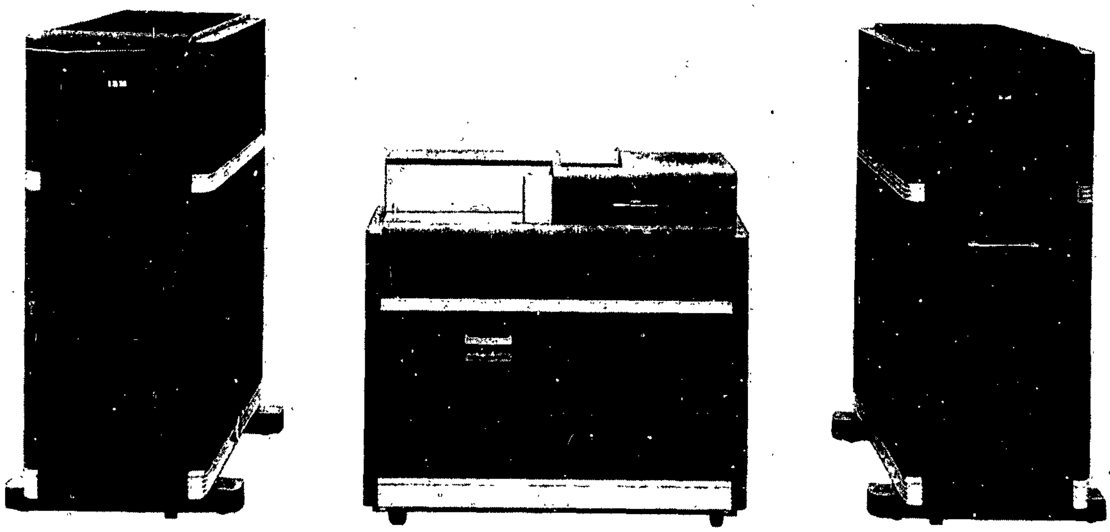


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

Business and scientific calculating.

Rossford Ordnance Depot

Located at Rossford Ordnance Depot, Toledo 1, Ohio, the system is used for inventory control and cost accounting (Comptroller).

U. S. Naval Ordnance Test Station, China Lake

Located at the Analysis Branch, Code 4535, China Lake Pilot Plant, China Lake, California, the system is used for theoretical propellant evaluation, rocket performance evaluation, and statistical analysis.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	3 or 5
Instructions used	10
Arithmetic system	Fixed point
Instruction type	One or two address
Number range	Variable

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	520
Mult	12,940
Div	15,700
Construction	Vacuum tubes
Basic pulse repetition rate	50 KC
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	Words	Access Microsec
Electronic Tubes	37	520

Rossford

Total storage is 37 words or 293 decimal digits.

US NOTS

Total storage is 14 words or 66 decimal digits.

INPUT OUTPUT

Medium	Speed
Card Reader-Punch	100 cards/min

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	2,584
Tube types	7

CHECKING FEATURES

Check possible through control panel wiring.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	13.5 KVA
Volume, computer	178.9 cu ft
Area, computer	36.5 sq ft
Weight, computer	4,330 lbs

Rossford

Power, computer	13.5 KVA
Volume, computer	178.9 cu ft
Area, computer	36.5 sq ft
Weight, computer	4,330 lbs

No significant requirements.

US NOTS

Power, computer	10 KVA
Volume, computer	78 cu ft
Volume, 529	38 cu ft
Area, computer	13.8 sq ft
Area, 529	9.2 sq ft
Room size	120 sq ft
Floor loading	25 lbs/sq ft
	121 lbs concen max
Weight, computer	2,780 lbs

Hood with exhaust fan over computer, 26,000 BTU heat load exhausted.

PRODUCTION RECORD

Number produced	Over 267
Delivery time	Availability basis

COST, PRICE AND RENTAL RATES

Manufacturer

Rental rates of basic system approximately $800 per month and up. Rental rate includes engineering maintenance and parts.

Rossford

Basic System

607 Electronic Unit	$550/month
529 Punch Unit	250/month

Additional Equipment

942 Electronic Storage Unit	$200 to $800/month

Maintenance/service is included in rental contract.

US NOTS

$940 per month (IBM 607 and IBM 529)

$1,295 per month, includes equipment for data preparation for 709 (2-IBM 026, 1-IBM 077, 1-IBM 082, 1-IBM 519, 1-IBM 523, 1-IBM 557, and 1-IBM 407).

Maintenance/service is included in rental contract.

PERSONNEL REQUIREMENTS

Rossford

Used in conjunction with other card punch equipment. No special handling is required.

US NOTS

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts, Programmers & Coders	4	4
Operators	2	2
Tape Handlers		2
Total	7	9

Operation tends toward closed shop.

Methods of training used are in-house plus IBM training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Rossford

Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

The IBM 607 Electronic Calculator is designed for use by business and industry. Because of its expanded capacity, the overwhelming majority of business calculations requiring multiple machine operations are performed and checked in a single operation. It is capable of performing and checking 14,000 computing operations a minute.

The memory capacity of the 607 makes it possible to use intermediate calculated results as well as original data in solving a problem. Other necessary information not punched in cards, such as tax percentages, discount rates, and overtime factors, may be entered as required.

Rossford

It is possible to use intermediate calculated results as well as original data in solving problems.

US NOTS

A unique system advantage is its availability for static test data reduction. It should be noted that this computer (IBM 607) is located 5 miles distant from the Station's IBM 709 system.

FUTURE PLANS

US NOTS

Proposal for 1401 System to replace present system.
Proposal for micro-wave hook-up with IBM 709 and Polaris test stand-digital data processor (to write 709 binary tape).

INSTALLATIONS

Rossford Ordnance Depot, Machine Records Division
Toledo 1, Ohio

U. S. Naval Ordnance Test Station
China Lake, California

Shell Oil Company

New York Life Insurance Company

Consolidated Edison Company
New York, New York

Bausch & Lomb Optical Company
Scientific Bureau
Rochester 2, New York

IBM 608

IBM 608 Transistorized Calculator

MANUFACTURER

International Business Machines Corporation

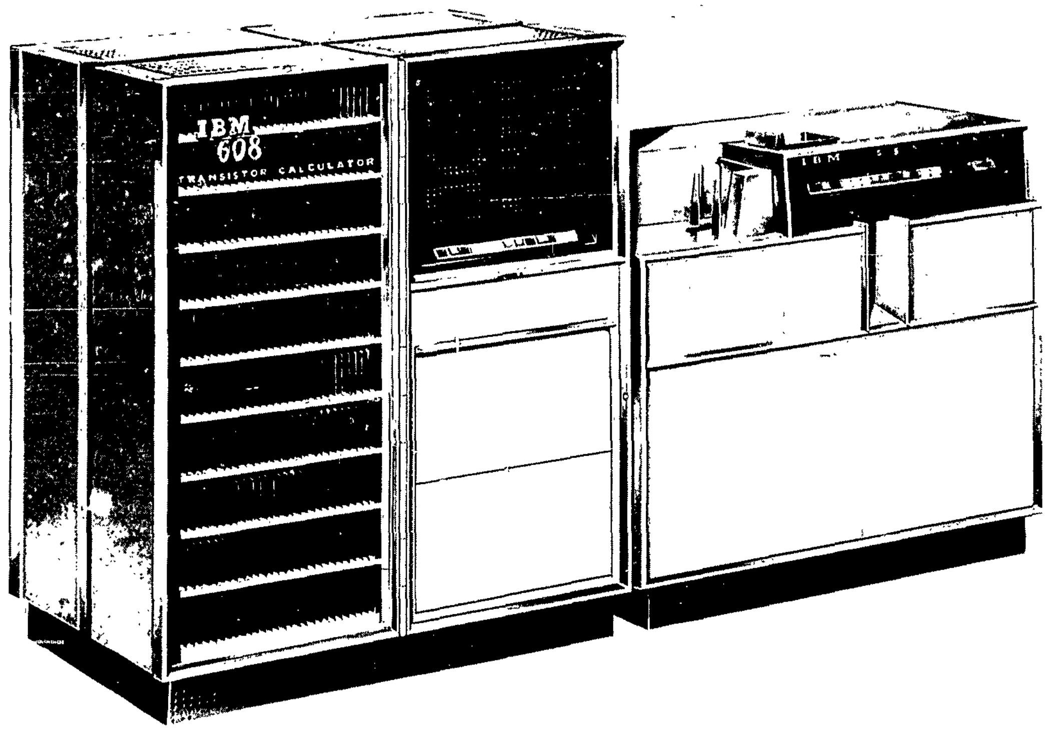


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer
Business and scientific computing

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	9
Instructions used	12
Arithmetic system	Fixed point
Instruction type	One or two address
Number range	Variable, depending on program

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	220
Mult	11,000 average
Div	13,420 average
Construction	Transistors and cores
Basic pulse repetition rate	100 KC
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	Words	Digits	Access Microsec
Magnetic Cores	40	360	220

Each word may be split into a 3 digit and 6 digit word with separate signs.

INPUT

Medium	Speed
Card Reader-Punch	155 cards/min

OUTPUT

Medium	Speed
Card Reader-Punch	155 cards/min

CHECKING FEATURES

Checking possible through control panel wiring.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	2.3 KVA
Volume, computer	160 cu ft
Area, computer	30 sq ft
Weight, computer	2,400 lbs

Photo by International Business Machines Corporation

PRODUCTION RECORD

Models have been produced and are in customer service. Production has been discontinued.

COST, PRICE AND RENTAL RATES

Rental rates of basic system $1,600/month and up. Rental rate includes engineering maintenance and parts.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

IBM's "608", the first completely transistorized calculator for commercial applications, operates without the use of a single vacuum tube.

Transistors-tiny germanium devices that perform many of the functions of conventional vacuum tubes-make possible a 50% reduction in computer-unit size and a 90% reduction in power requirements over a comparable IBM tube-model machine. They are mounted, along with related circuitry, on banks of printed wiring panels in the 608.

The machine's internal storage, or "memory", is made up of magnetic cores-minute, doughnut-shaped objects that can "remember" information indefinitely, and recall it for use in calculations in a few millionths of a second.

For IBM, the 608 marks the achievement of production techniques for the manufacture, on a large scale basis, of computing and data processing equipment combining transistors, printed circuits and other forms of miniaturization.

IBM 609

IBM 609 Calculator

MANUFACTURER

International Business Machines Corporation
Monterey and Cottle Roads
San Jose, California

Photo by International Business Machines Corporation

APPLICATIONS

Commercial and scientific applications, especially where IBM cards are used presently with IBM 604, 607 and 608 calculators. This machine is a modular, solid state, one-unit calculator designed to expand the area of applications performed by the above machines. The 609 is a numerical card in-put, card out-put calculator offering a substantial increase in internal operating and arithmetic speeds.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	12
Decimal digits/instruction	Control panel
Control panel logic wired	
Arithmetic system	Yield on card - arrangement by control panel wiring
Instruction type	Two addresses per program step (Control panel wiring)
Instruction word format	

Control panel wiring

Not a stored program machine. 2nd cycle subtract or conversion to true number in storage.

Maximum 384 positions of core storage. All positions may be used. Operation is of the add-to-memory-type.

Read words	Max. - 144 pos.
Punch words	Max. - 96 pos.
Process words	Max. - 144 pos.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	6-digit fields: 224
Mult	6-digits x 6 digits: 13,860
Div	6-digit dividend & quotient: 17,640
Arithmetic mode	Serial
Timing	Synchronous
Operation	Non-sequential

Approximately 95% of all the transistors used in the system are considered as being in the arithmetic function. Condenser-quantity 1,354, nineteen different values.

STORAGE

Media	No. of Words	No. of Digits
Core Storage		
Basic - Model A-1	Read 8; Punch 8; Process 4	96, 96, 48
Max. - Model A-1	Read 12; Punch 8; Process 12	144, 96, 144
Basic - Model B-1	Read 4; Punch 3; Process 0	48, 36, 0
Max. - Model B-1	Read 7; Punch 6; Process 3	84, 72, 36

INPUT

Medium	Speed
Cards	200 cards/min

The card input has 3 card stations: a first reading station, a punch station, and a second reading station. Cards are placed in a 1,200-card-capacity hopper face down, 12-edge first. The cards feed continuously from one station to the next at the rate of 200 cards per minute. Thus, while one card is being read for calculation, another is being punched, and a third card may be read for checking, gang punching, etc., or for recalculation. Input and output (double-punched blank-column) are checked.

OUTPUT

Medium	Speed
Punched Cards	200 cards/min (max)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	
Diodes	5,194	(Various types)
Transistors	1,887	(Various types)
Magnetic cores	2,500	
Selenium rectifiers	130	
Condensers	1,354	(19 different values)

Approximately 95% of all the transistors used in the system are considered as being in the arithmetic functions.

CHECKING FEATURES

All input, calculated, and output information is tested for error conditions. Output (DPBC detection) and additional position checking is optional. The 609 Calculator uses a unique type of matrix-analysis adder which includes the checking bit in its arithmetic operation.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1 Kw
Volume, computer	50 cu ft
Area, computer	12.08 sq ft
Floor loading	116 lbs/sq ft 1,400 lbs concen max
Weight, computer	1,400 lbs

A 15 ampere, 115 volt, 60 cycle/sec, single phase AC line is required.

PRODUCTION RECORD

Time required for delivery 12 months

COST, PRICE AND RENTAL RATES

Basic System	Cost	Monthly Rental
Model A-1 (complete system)	$55,500	$1,175
Model B-1 (complete system)	36,000	735

Additional Equipment
Number of groups for each model

A-1	B-1		Cost	Monthly Rental
4	3	Program Steps - each group	1,200	30
4	3	Storage - each group	1,200	30
4	3	Each decision feature	1,200	30
2	2	Digit Test	600	
2	1	Digit Selector	240	
2	2	Adder overflow selector	200	
4	3	DPBC; each group	370	

Maintenance contract available.

PERSONNEL REQUIREMENTS

One operator/shift is required.
Training made available by the manufacturer to the user at IBM Education Centers and at some local branch offices.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Modular standard packaging and solid state hardware.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include non-sequential branching logic, fast access magnetic core storage, direct add storage words, 200 cardsper minute, no special voltage requirements (115 volts), no air conditioning, 3 radial stackers, solid state, modular, one-unit calculator.
System advantages include fast access magnetic core storage, 12 and 16 digit words, direct-add storage word - every word addressable, and high speed reading and punching.

INSTALLATIONS

International Business Machines Corporation
Monterey and Cottle Roads
San Jose, California

IBM 610

IBM 610 Autopoint Computer

MANUFACTURER

International Business Machines Corporation

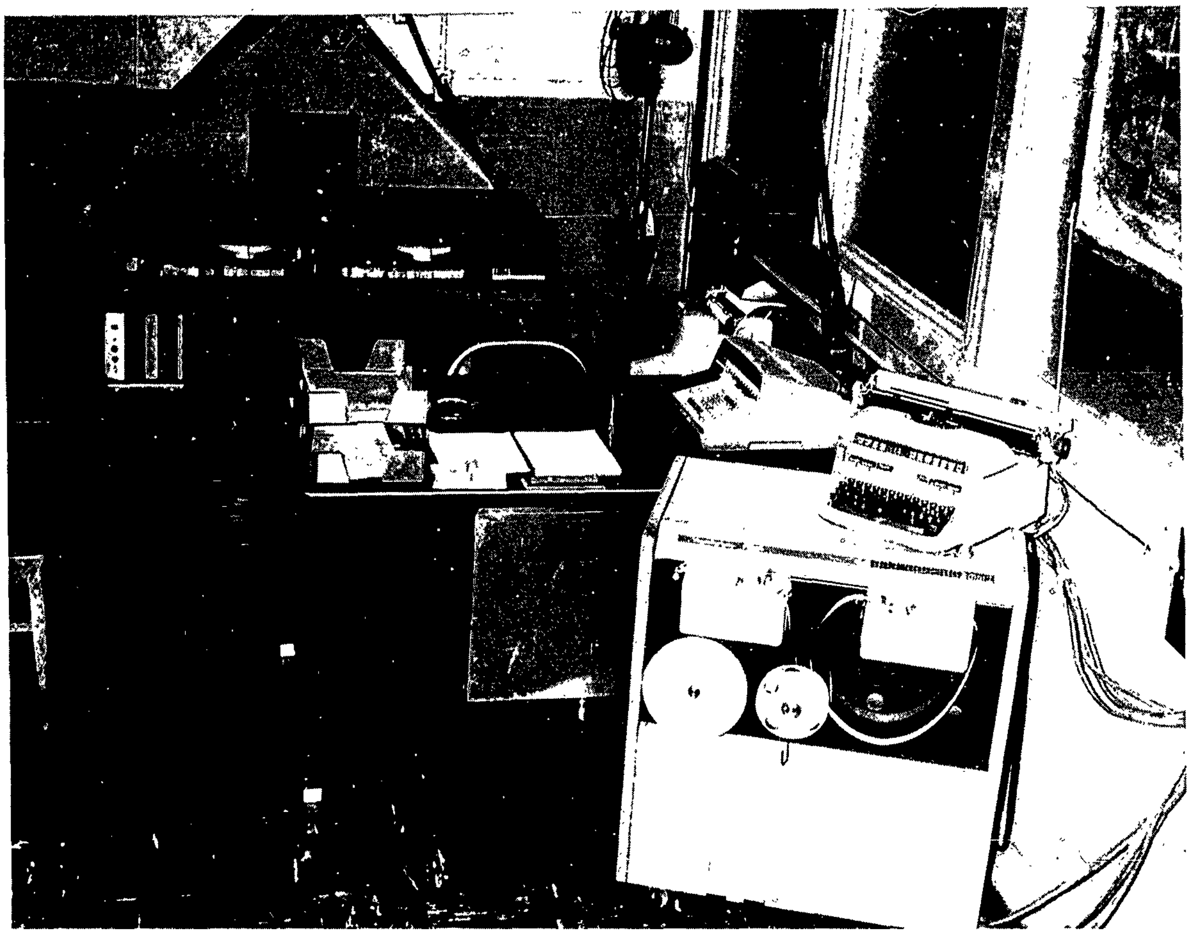


Photo by U.S. Naval Ammunition Depot, Crane, Indiana

APPLICATIONS

Manufacturer

Applications of the 610 Autopoint Computer include heat transfer calculations, analysis of mass spectrometric data, formulae evaluations, calculation of aeroelasticity, stress analysis, flutter and vibration analysis, data reduction, highway design, bridge design, surveying problems, matrix arithmetic, correlation and regression analysis, sales forecasting, actuarial calculations, analysis of variance, curve fitting, experimental design, and many other applications.

Ordnance Missile Laboratories Division
Army R--ket and Guided Missile Agency

Located a_ the Design and Development Lab and Systems Analysis Lab, OML Division, ARGMA, the computer is used for data reduction and theoretical investigation.

Mathematical Sciences Division, Research Directorate, U.S. Army Transportation Research Command

Located at USA TRECOM, Building 401, Fort Eustis, Virginia, the system is used for curve fitting, data reduction, regression analysis, analysis of variance, correlation analysis, evaluation of analytic expressions, including effects of neutron radiation on cargo, effects of nuclear weapons on Army aircraft, helicopter control system analysis, and helicopter design, and matrix arithmetic.

Control Office, Ordnance Mission, White Sands Missile Range

Located at the Guidance Laboratory, Building 1676, Electro-Mechanical Labs., Ordnance Mission, White Sands Missile Range, New Mexico, the system is used for data evalutaion, technical support of engineering evaluation studies, etc. Users are primarily

Photo by E. I. DuPont de Nemours and Company, Inc.

from the Ground Guidance Branch, Missile Borne Guidance Branch, Structures Branch and Propulsion Branch.

Weapons Dept., U. S. Naval Academy
Located in Ward Hall, U. S. Naval Academy, Annapolis, Md., the system is used to demonstrate to Naval Academy Faculty and Midshipmen, semi-automatic and automatic calculations using a small scientific type digital computer. Application to date includes two dimensional target relative motion studies, ballistic trajectory studies, and sound in water studies.

U. S. Naval Ammunition Depot
The system is located at U. S. NAD, Q. E. Laboratory. The major problems for which this activity uses the IBM 610 Computer are statistical and engineering. Statistical uses include mean and standard deviation, two and three way correlation, regression analysis, pxq analysis of variance, many specific factorial analysis of variance, and response surface analysis. Engineering calculations vary from tabulation of simple equations in two and three variables to relatively complex problems such as the solution of second order differential equations which must be solved numerically.

Tennessee Valley Authority, Computing Center
Located in the Chemical Engineering Building, Wilson Dam, Alabama, the 610 is used in the general area of chemical research. Specific problems include chemical kinetics, thermodynamics and some structure work.

E. I. DuPont de Nemours & Co.
Located in Room 224, Laboratory Building, the system is used for material balances, thermal efficiency calculations, heat transfer calculations, return on investment calculations, equipment design, process control correlations, statistical analyses, including multiple linear regression, simple linear correlation, and analysis of variance, preparation of process operating tables, calculation of finished product intermediate requirements, and pressure drop calculations for plant application.

General Tire and Rubber Company
Located at 1708 Englewood Avenue, Akron, Ohio, the system is used for tire development, quality control, research and development. Engineering and scientific uses only.

Military Systems Div., Lockheed Electronics Co.
Located on U.S. Highway No. 22, Plainfield, New Jersey, the system is used for the solution of engineering problems such as radar coverage diagram, curve fitting of experimental data, and numerical analysis.

Carleton College
Located at Carleton College, Northfield, Minnesota, the system is used for undergraduate programming instruction, undergraduate numerical analysis instruction, student independent study, and faculty research.

Computing Laboratory, University of Louisville
Located at the Speed Scientific School, University of Louisville, Louisville 8, Kentucky, emphasis has been on the introduction of digital computer as an effective tool of numerical analysis. Both graduate and undergraduate students are permitted time to work their problems on the computer.

Computation Lab., University of Rhode Island
Located at Taft Laboratory, University of R. I., Kingston, R. I., the system is used for the solution of problems in such areas as mathematics, physics, civil engineering, electrical engineering, agricultural economics, agronomy, horticulture, marine biology, industrial management, and poultry husbandry.

Computation Facility, Worcester Polytechnic Institute
Located in Room 3, Stratton Hall, Worcester Polytechnic Institute, the system is used primarily for education in the use of digital computation in engineering and science and secondarily, for research requiring digital computation.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Decimal or Octal
Decimal digits/word	15 plus sign
Arithmetic system	Fixed and floating point
Instruction type	One address

ARITHMETIC UNIT

Manufacturer

Arithmetic speed - Seconds

Operation	Flo Point	Fixed Point
Add or Subtract	0.28	0.28
Multiply	1.37	1.155
Divide	1.43	1.155
Divide-Multiply	1.54	1.155
Square-root	2.23	1.90

STORAGE

Manufacturer

Medium	No. of Words	Dec Digits/Word
Magnetic Drum	84	31 plus sign

INPUT OUTPUT

Manufacturer

Program Tape Reader and Punch
Reads at 18 characters per second, approximately 1.18 seconds to complete read in, tape is prepared while keying in program and can be read back for automatic processing.

Data Tape Reader and Punch
Reads at 18 characters per second, approximately 1.06 seconds to complete read out, original data or intermediate results can be punched and read back.

Manual Keyboard
Complete manual control of machine, control lights to indicate internal operations, instruction keys for program tape preparation, manual data entry and problem solution, and visual display of all machine registers.

Electric Typewriter
Typed output at 18 characters per second, manual operation to permit alphabetic headings for reports, typewriter up to 10 feet from machine, and automatic carriage return and tab instruction.

Cathode Ray Tube Display
Two inch tube for display, and 32 x 10 grid defines register contents. Decimal point and sign displayed.

Control Panel
Convenient method of handling sub-routines, 200 program hubs for additional programming, 12 balance test hubs for logical either-or decisions, 15 program skips for program transfer, and 10 selectors for program alteration.

USNAD
The ratio of input time to computing time for most statistical problems of any complexity is less than one. The ratio of output time to computing time for most statistical and engineering problems is small except for large problems where intricate programming requires temporary storage of large quantities of data on the data tape. Small internal storage makes programming of large problems intricate.

CHECKING FEATURES

Manufacturer
Checking features include circuit and components designed for reliability, validity check of each tape character read in and read out, all information transfer within 610 validity checked, auto-point sums, products and quotients checked not to exceed machine capacity, all clear operations checked to insure complete reset to zero, and all register addresses validity checked.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer
105-130 volts, single phase, 60 cycle, AC, 16-20 amperes. Heat dissipation is 5,000 BTU/hour. 60° to 95°F temperature range, 95% maximum humidity.

ARGMA

Power, computer	1.5 Kw	1.5 KVA	1.0 pf
Volume, computer		42 cu ft	
Area, computer		14 sq ft	
Room size, computer		8 ft x 10 ft	
Floor loading		54 lbs/sq ft	
		190 lbs concen max	
Weight, computer		750 lbs	

30 amp fuse on separate line. No special air conditioner required.

USA TRC

Power, computer	2.4 KVA 105-130V, 60 cycle, 16-20 amp
Volume, computer	26.5 cu ft
Area, computer	8.8 sq ft
Room size, computer	Small
Floor loading	8.6 lbs/sq ft
	800 lbs concen max
Weight, computer	750 lbs

Installed a separate 120V, 60 cycle, 30 amp line.

WSMR

Power, computer	120V single phase, 17.1 Amperes
Area, computer	5x3.5x2.5 ft
Weight, computer	800 lbs

Adequate power plus ventilation. Built in blower.

US NA

Power, computer	110V, single phase, 20 amp, 60 cycle
Volume, computer	33.5 cu ft
Area, computer	10.2 sq ft
Room size, computer	20 ft x 40 ft(Classroom)
Floor loading	80 lbs/sq ft
	800 lbs concen max
Weight, computer	800 lbs

USNAD

Power, computer	1 Kw	2 KVA	0.5 pf
Volume, computer		30.7 cu ft	
Area, computer		9.2 sq ft	
Room size		200 sq ft	
Floor loading		10 lbs/sq ft	
		87 lbs concen max	

Weight, computer	800 lbs

No air conditioner is required. Special individual computer power supply wiring. Heat removal blower.

TVA

Power, computer	1.65 KVA
Volume, computer	50 cu ft
Area, computer	15 sq ft
Weight, computer	1,100 lbs

No air conditioner needed.

DuPont

Power, computer	2.34 Kw
Power, air condi 1.75 Kw	0.21368 KVA 0.91 pf
Volume, computer	15.9 cu ft
Volume, air conidtioner	5.63 cu ft
Area, computer	14.7 sq ft
Area, air conditioner	3.11 sq ft
Room size	19 ft 1 in x 9 ft 3 in
Floor loading	140 lbs/sq ft
	1,200 lbs concen max
Weight, computer	1,150 lbs
Weight, air conditioner	178 lbs

Separate 20 ampere, 117 volt service.

General Tire

Volume, computer	800 cu ft
Area, computer	100 sq ft
Room size	10 ft x 10 ft

Lockheed Electronics

Power, computer 1.44 Kw	1.44 Kw
Volume, computer	31.5 cu ft
Area, computer	9.2 sq ft
Room size	9 ft x 14 ft
Floor loading	6.35 lbs/sq ft
	87 lbs concen max
Weight, computer	800 lbs

Site preparation included soundproof room 9 ft x 14 ft, false ceiling, 80 watt fluorescent lighting, electric fan, and 115 volt - 60 cycle - single phase-20 ampere electrical line.

U of Louisville

No special preparation was required. The room has concrete block walls and acoustic ceiling, tile and concrete floor.

Worcester Poly

Power, computer	2.3 Kw
Volume, computer	24 cu ft
Area, computer	8 sq ft
Room size	15 ft x 20 ft
Floor loading	100 lbs/sq ft
	200 lbs concen max
Weight, computer	800 lbs

New partitions, acoustic ceiling, fluorescent lighting, redecorating, one special power circuit, regular electrical outlets.

PRODUCTION RECORD

Manufacturer

System has been dropped and is no longer available.

COST, PRICE AND RENTAL RATES

Manufacturer

Unavailable from manufacturer

ARGMA

Rental rate is $1,100 per month.

USA TRC

Console, keyboard, and typewriter rent at $1,150/mo.

WSMR

$1,150 per month for all 610 equipment.

US NA

$460 per month - computer, keyboard, typewriter (includes academic contribution of 60%).

USNAD

$1,283 per month for basic system.

Remington Rand Synchro Tape is rented for $142/mo.

Maintenance/service contracting is included in rental rates.

TVA

The 610 console, 869 typewriter, 973 keyboard cost $55,000.

System rents at $1,150/month.

DuPont

Computer cost $55,000 and rents for $1,150 per month, including console, keyboard, and typewriter.

The off-line punch rents at $125 per month.

Maintenance/service contract

	0-36 Months	37-72 Months	73-108 Months
Console	$112/Mo	$142/Mo	$191/Mo
Typewriter	11	15	-
Keyboard	2	3	4

General Tire

Approximately $1,100 per month is paid.

Lockheed Electronics

	Monthly Rental
Console	$1,065
Typewriter	35
Keyboard	50
Tax	115
	$1,265

U of Louisville

$460 monthly (basic system costs about $50,000).

Maintenance is included in rental.

U of R. I.

The IBM 610 rents $460 per month.

026 card punch, 402 accounting machine, 101 electronic statistical machine, and 514 reproducing punch rent at $500 per month.

Worcester Poly

IBM 610: $460/month (educational contribution rate), including maintenance.

PERSONNEL REQUIREMENTS

ARGMA

10 engineers and 4 technicians utilize machine on an as needed basis. No full time personnel assigned or needed.

Operation tends toward open shop.

USA TRC

One supervisor and 2 or 3 programmers. One operator is required for each shift.

Operation tends toward open shop.

Methods of training used includes in-house instruction to members of the command conducted by members of the Mathematical Sciences Division.

WSMR

One Theoretical Physicist (BA) does all programming, etc. (IBM maintains equipment).

Operation tends toward closed shop.

IBM has run several one week courses (4 hrs per day) on operation of 610.

US NA

One operator required.

Operation tends toward open shop.

Methods of training used includes classroom instruction.

USNAD

	One 8-Hour Shift
Supervisors	1/4
Analysts	1/2
Programmers	1/2
Operators	1
In-Output Oper	1

Mathematical aptitude was determined by qualifying tests and other criteria and further training was on-the-job in nature.

TVA

There is no one person designated in a supervisory capacity for the 610. The computer is used a great deal by about six or eight chemical engineers, and is periodically used by about six or eight more.

Two-day training classes, taught by IBM personnel, are offered periodically as needed.

DuPont

Four engineers use the system.

Operation tends toward open shop.

IBM conducted 2 day class for training - this included "hands-on" training.

General Tire

Used by engineering and research personnel who do their own programming and operating.

Lockheed Electronics

	One 8-Hour Shift
Supervisors	1
Programmers	2
Engineers	10

Operation tends toward closed shop.

Methods of training used include the instruction manual, brief kecture, and demonstration. Typical personnel able to operate and program the computer one day training and experience.

U of Louisville

Operation tends toward open shop.

Formal course work: Math 400 Machine Computing, 1 credit hour (1 hr lecture and 2 hr lab each week for 10 weeks).

Worcester Poly

	One 8-Hour Shift Used	Recommended
Supervisors	1/3	1
Clerks	1/15	1/2
Operators	(Users)	1/2

Operation tends toward open shop (exclusively).

Methods of training used includes short special courses as required and training is included in several regular academic courses.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

ARGMA

Good time 30 Hours/Week (Average)
Attempted to run time 30 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 1.0
Above figures based on period from Nov 59 to May 60
Passed Customer Acceptance Test Nov 59
Time is not available for rent to outside organizations.

USA TRC

Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating Ratio (Good/Attempted to run time) 0.95
Above figures based on period 17 Mar 60 to 27 Jul 60
Passed Customer Acceptance Test 17 Mar 60
Time is not available for rent to outside organizations.

WSMR

Time is available for rent to outside organizations. The computer has been down for repair less than 5% of time in past year.

USNAD

Good time 39.2 Hours/Week (Average)
Attempted to run time 40.7 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.962
Above figures based on period 26 Apr 59 to 31 Jul 60
Passed Customer Acceptance Test 12 Apr 60
Time is not available for rent to outside organizations.

The IBM 610 has been very reliable and has had an excellent good time record. The time availability has in general been based on a 40 hour week.

TVA

Average error-free running period 4 or 5 days
Passed Customer Acceptance Test Nov 59
Time is not available for rent to outside organizations.

Down time is sporadic and for the most part insignificant.

DuPont

Average error-free running period 20 Hours
Good time 33 Hours/Week (Average)
Attempted to run time 35 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period 5 Jan 60 to 5 May 60
Passed Customer Aceptance Test 5 Jan 60
Time is not available for rent to outside organizations.

General Tire

Time is not available for rent to outside organizations.

Lockheed Electronics

Average error-free running period 3 1/2 hours/week
Good time 4 to 5 Hours/Week (Average)
Attempted to run time 4 & 5 Hours/Week (Average)
Operating ratio 0.99
Above figures based on period 13 Nov 54 to 14 Apr 60
Passed Customer Acceptance Test 12 Nov 59
Time is available for rent to qualified outside organizations. Duration time of job must be long enough to justify moving the computer to an unclassified area.

Carleton

Average error-free running period 3 Months
Good time 40 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 1.0
Above figures based on period 1 Feb 60 to 31 Aug 60
Passed Customer Acceptance Test Nov 59
Time is not available for rent to outside organizations.

U of Louisville

Time is available for rent to outside organizations.

U of R. I.

Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Above figures based on period from Aug 59 to present
Passed Customer Acceptance Test 17 Jul 59
Time is available for rent to qualified outside organizations.

Worcester Poly

Good time 30 Hours/Week (Average)
Attempted to run time 35 Hours/Week (Average)
Operating ratio 0.85
Above figures based on period from Jan 59 to Jun 60
Passed Customer Acceptance Test 21 Jan 59
Time is available for rent to qualified outside organizations.

Use by outside organizations has been possible only via sponsored research and educational uses. IBM contract (dated 1 Jun 60) permits sale of time to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Tape Characteristics

Automatic adjustment to 5 or 8 channel size, 5 channel teletype tape, and 8 channel includes: 5 for code symbols, one for even-order redundancy check, and two for class marks (for operating use).

The IBM 610 is tailored to needs of engineering and science, mobile desk-size unit with typewriter and keyboard, handles 5 or 8 channel punched paper tape, 15 digit number plus decimal and sign, automatic control of decimal point, 84 registers of magnetic drum storage, each 31 digits, plus sign, octal or decimal arithmetic, single instruction square root, single instruction divide-multiply (x/y)z, program control from-keyboard, program tape and control panel, automatic program tape preparation while solving problem, built-in self-checking for reliability, and multiple-command instructions.

Keyboard Lights

KEY BD	Keyboard in control
OPE	Machine executing a step when automatic program stops
INT	Indicates interruption of a program
PCH CLASS	Punch class switch (1,2,3) ON
CLEAR	Register has failed to clear to zeros
PUNCH	Invalid character punched into tape
REG	Invalid register address
DIG ENT	Invalid Numerical Code entered
RDN	Invalid character read in or out
DIG CH	Signals or digits from or to drum are invalid
OFLO	Number in SEL REG exceeds allowable magnitude or division by zero attempted

USA TRC

Outstanding feature is ease of programming.

US NA

Outstanding features include automatic decimal point, each memory drum register capable of storing 31 decimal digits plus sign and decimal point, and option of octal or decimal mode of operation. System is easy to program and operate.

USNAD

Outstanding features include auto-point (floating point) calculations, good reliability, and ease of programming.

TVA

Since this computer is used by a relatively small integrated group, tape storage is no problem. Each operator takes care of his own special tapes, while standard tapes are labelled and filed close to the computer.

DuPont

Outstanding features include automatic decimal point, easy programming, and programming in engineering language.

Lockheed Electronics

Outstanding features include computes and prints-out in floating point point notation, very fast and easy to program, and air conditioning not required. Duration time of arithmetic operation too long especially those for trigonometric function, i.e., multiply - 0.78 sec., square root - 0.67 sec., and sine (cosine) at least 20 sec.

Carleton

Outstanding features are ease of programming (simple command structure) and use as desk computer.

U of Louisville

Unique system advantages are automatic positioning of decimal point and simplicity in coding.

Worcester Poly

Outstanding features includes low cost, bringing it within the range of a limited, small college budget, simplicity in learning to use it, and minimum personnel requirements.

Additional computing equipment available on campus includes two small analog computers and one home-made demonstration digital computer in various engineering departments. For large scale digital computing applications W.P.I. has limited access to the MIT Computation Center.

FUTURE PLANS

USA TRC

It is proposed that the system be replaced by an IBM 1620.

USNAD

The rental of the IBM 1620 Digital Computing System has been approved by the Bureau of Naval Weapons. The IBM 1620 has much faster input and computing times (input of 180 char/sec and access time of 20 microsec). In addition the 1620 has core storage of 20,000 digits with variable word length. The rental of the IBM 1620 will be approximately $1,600 per month.

TVA

The workload is increasing rapidly and may require some change in the future. Present plans are indefinite.

DuPont

To date, primary usage of the IBM 610 has been in the development and research areas for engineering calculations and evaluation and analysis of experimental data. Continued use in this field is anticipated. More complex applications in the statistical field will be pursued in the plant process and product areas. Increased activity in the production and cost accounting department is expected. At this time, no plans for an expansion or modification of the present computer system has been made. However, the adequacy of the present system for current and future demands will be studied within the next six months. Results and recommendations of this study will determine the need for expansion or acquisition of a new system.

Lockheed Electronics

IBM 610 to be replaced by IBM 1620.

Worcester Poly

Eventual acquisition of some other computer as addition to or replacement for present one, possibly to meet administrative as well as educational and research needs.

INSTALLATIONS

Army Rocket & Guided Missile Agency, Redstone Arsenal, Alabama

U. S. Army Transportation Research Command, Mathematical Sciences Division, Fort Eustis, Virginia

Ordnance Mission, White Sands Missile Range, N. Mexico

U. S. Naval Academy, Weapons Dept., Annapolis, Md.

U. S. Naval Ammunition Depot, Crane, Indiana

Tennessee Valley Authority, Computing Center, 116 Old Post Office, Chattanooga, Tennessee

E.I. DuPont de Nemours & Co., P.O. Box 1378, Louisville 1, Kentucky

General Tire & Rubber Co., 1708 Englewood Ave., Akron 9, Ohio

Lockheed Electronics Co., Military Systems Div., U.S. Highway No. 22, Plainfield, New Jersey

Carleton College, Northfield, Minnesota

University of Louisville, Louisville 8, Kentucky

University of Rhode Island, Kingston, Rhode Island

Worcester Polytechnic, Computation Facility, Worcester 9, Massachusetts

IBM 632

IBM 632 Electronic Typing Calculator

MANUFACTURER

International Business Machines Corporation
Electric Typewriter Division

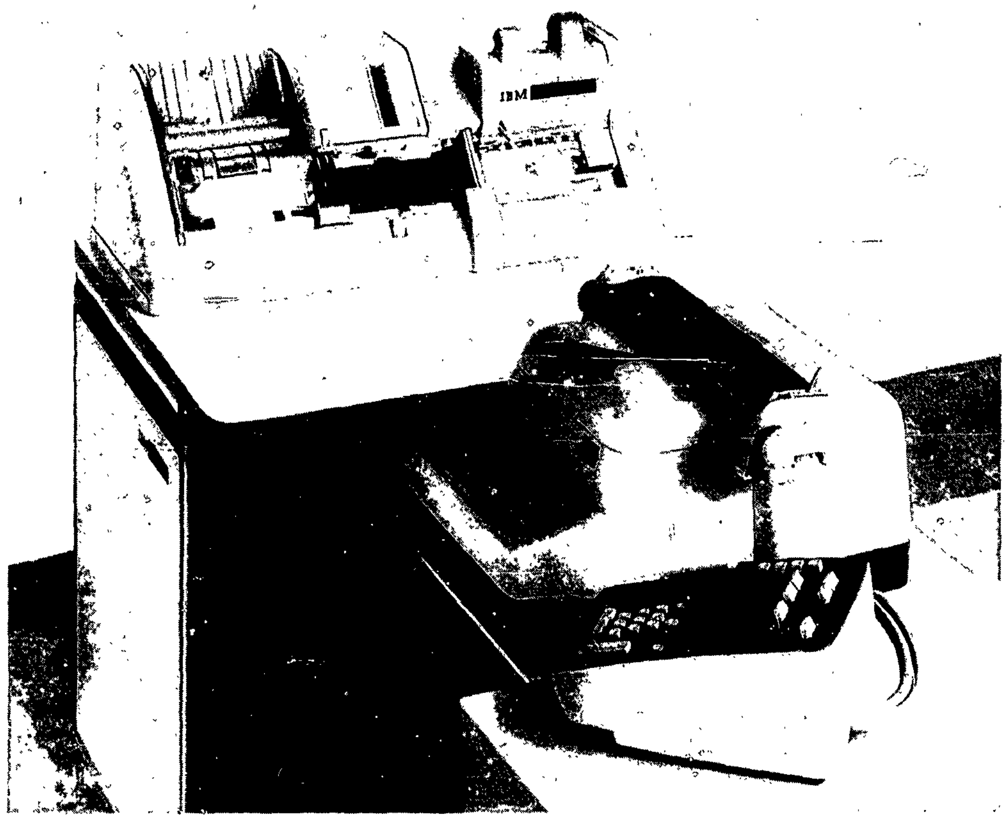


Photo by International Business Machines Corporation

APPLICATIONS

The IBM 632 is designed primarily for invoicing. It is available in four models, including models with card punch, printing card punch, and punched paper tape output. The 632 combines calculating and typing in one unit. It automatically adds, subtracts, and multiplies the information keyed into the companion keyboard. It also automatically inserts decimal points, computes taxes, discounts and accumulates information for daily totals. The accuracy of electronics and magnetic core "memory" give the IBM 632 Electronic Typing Calculator the ability to handle a variety of business applications. This model, incorporating punched card output, punches desired information into IBM punched cards simultaneously with the typing action. The cards may then be further processed in an accounting system.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	12
Instructions decoded	12
Arithmetic system	Fixed point
Instruction type	One address

1 buffer register and 1 companion keyboard is used.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	110,000	21.5/word
Mult	2,500,000	430,000 (average)

Construction (Arithmetic unit only)

Vacuum tubes	150
Magnetic cores	164
Ferrite cores	352
Switch cores	28

Arithmetic mode	Serial
Timing	Asynchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Cores	8	12	21.5/word

INPUT

Medium	Speed
10 Key Unit	12 digits/sec Binary coded input

OUTPUT

Media	Speed
Typewriter	10 char/sec
Cards	10 char/sec
Paper Tape	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
6887	48
5965	41
5844	45
2D21	5
6350	11
Diodes	
1N152	11
-	117
1N480	24
-	12
Magnetic Cores	352

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.75 Kw	1.035 KVA
Volume, computer		9.5 cu ft
Area, computer		4.5 sq ft
Weight, computer		600 lbs

PRODUCTION RECORD

Time required for delivery	4-9 months

COST, PRICE AND RENTAL RATES

Basic System	Cost	Monthly Rental
Model I-Typewriter unit, calculator unit and companion keyboard	$6,000	$175
Additional Equipment		
Model II-Typewriter unit, calculator unit w/non-printing punch & companion keyboard	8,700	235
Model III-Typewriter unit, calculator unit w/printing punch & companion keyboard	9,800	260
Model IV-Typewriter unit, calculator unit w/tape punch & companion keyboard	11,900	295
Model V-Typewriter unit, calculator unit & companion keyboard & card reader	13,700	310
Model VI-Typewriter unit, calculator unit w/non-printing punch & companion keyboard & card reader	16,400	370
Model VII-Typewriter unit, calculator unit w/printing punch & companion keyboard & card reader	$17,500	$395

Maintenance/service is included in all monthly rental prices.

Maintenance/service for purchase machines is as follows:

Model I	$300
Model II	420
Model III	440
Model IV	535
Model V	472
Model VI	592
Model VII	612

PERSONNEL REQUIREMENTS

One operator is required per 8 hour shift.

Training made available by the manufacturer to the user includes operator training at time of installation.

ADDITIONAL FEATURES AND REMARKS

Outstanding features are a program reading device, which houses a mylar program belt, containing all of the instructions for a particular application, and a companion keyboard, which has a familiar 10-key pattern, facilitating indexing of numerical information, increasing speed and accuracy, and also aiding in error detection and correction. Unique programming device makes the equipment compatible with most systems.

INSTALLATIONS

International Business Machines Corporation
Electric Typewriter Division
590 Madison Avenue
New York 22, New York

IBM 650 RAMAC

IBM RAMAC 650 Data Processing Machine

MANUFACTURER

International Business Machines Corporation

Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

General purpose, applicable to scientific and business data processing. "In-line" processing with IBM RAMAC 650.

The IBM 650 is a basic magnetic drum data processing machine with an IBM 355 random access memory unit. This memory is a storage medium in which any group of data may be reached quickly and directly, despite the fact that the data is stored in the memory in a random fashion.

The RAMAC 650 was one of the first of IBM's line of machines designed for high-volume, in-line processing of business data. Instead of accumulating data to be processed in batches, each transaction is processed as it happens and, at the same time, every related record in the memory unit is adjusted.

U. S. Army Engineer District

Located in the Faidley Building, 121 South 16th Street, Omaha, Nebraska. The system with drum storage and card input-output is used for earthwork cut and fill, survey computations, stability analyses (spillway weirs, walls, powerhouse and spillway chutes), flood routing, reservoir regulation, grain size computations, and sediment load studies.

U. S. Army Engineer Research & Develop. Lab.

Located at Fort Belvoir, Virginia. The system with drum storage and card input-output, is used for the computation of problems in all fields of engineering in connection with Research and Development of military items for the Corps of Engineers, plus a small amount (less than 5%) of data processing in connection with labor distribution costs and similar reports.

U. S. Army Engineer Waterways Exper. Station

Located at Vicksburg, Mississippi. The system with drum storage and card input-output, is used exclusively for engineering and scientific applications. The Computer Center is a joint facility of the Waterways Experiment Station (WES) and the Lower Mississippi Valley Division (LMVD) of the Corps of Engineers, U. S. Army. It operates as a central (center-type) facility to provide electronic data processing and computation services to six (6) using field offices of the Corps of Engineers.

U.S. Army Corps of Engineers, U.S. Army Engineer Division.

Located at North Pacific Custom House, Portland 9, Oregon, the system is used primarily for scientific and engineering work arising in conjuction with the Corps of Engineers construction program in the North Pacific Division. Some typical programs are:

Program computes grounding mat resistance vs. cost per number of ground rods for selected ~~resistivities~~, ground rod spacings and ground rod lengths.

Program derives information for plotting the flux distribution in core form transformers for non-symmetrical coil arrangements or non-uniform current densities.

Program computes the neutral axis of a reinforced concrete section of any shape subjected to any combination of axial load, P, and bending moments, M_x and M_y and computes the concrete and steel stresses. The program can be used for stability analyses and base plate stress analyses, etc., with proper formulation of input data.

Computes backwater or water surface profile in an open channel by the standard-step method for velocities less critical. The program computes water surface elevations and balances energy equation to the desired accuracy.

Program derives the streamflow from snowmelt and/or rainfall over various segments of the Columbia River Basin, by routing water thru basin, lake, and channel storage, thereby determining streamflow at gaging stations for reservoir regulation of design

Photo by U.S. Army Anniston Ordnance Depot

flood studies.

Monthly forecasts of water year and residual volumes of river flow are prepared for 132 river stations in the Columbia Basin and coastal areas, for purposes of power, irrigation, flood forecasting and control. The program computes forecasts and prepares page formats for publication.

The program simulates a basin-wide hydroelectric system of up to 60 projects, giving power output, storage and regulated streamflow data for the projects. Input to the routines are project characteristics, streamflow network, periodic unregulated streamflows, and storage changes at the projects. A sequence of up to six storage projects may be designated for use in firming the system to a pre-specified energy load for each period. Program 1050.4 is for a 650 with 4000 words of internal storage memory.

This program simulates a hydroelectric system of up to 20 projects on a given river and its tributaries. The program output gives total discharge, spill, turbine discharge, forebay and tailwater elevations, head on power plant, and actual station generation, number of units on the line for each of the projects, and the total system generation. Variable input data are as follows: desired generation, local inflow, required spill and miscellaneous water use. Time interval for input data is variable and time interval for output data is variable; however, hourly data will ordinarily be computed. Flows are routed between projects, either through reservoirs or open channel reaches. Routing constants and power plant characteristics are included in the program along with minimum and maximum pool elevation but may be changed as desired.

Program determines the total energy in kw-months, mean monthly capability in kw, average number of operating units and mean head associated with a sequence of mean monthly flows at a hydro-generating plant. Plant performance is based on turbine unit performance characteristics and generator losses contained in tables in memory and a constant value of transformer efficiency.

Computes cut and fill, adjusted cut, accumulated cut and fill, mass ordinate and slope stake reference data where required, based upon original ground and finished ground conditions.

The computation of earthwork quantities and preparation of design roadway templates and profile grades are processed. The stations and elevations of the verticle P.I.'s together with the length of verticle curves, and the station of the points of spiral and horizontal curves, the roadway typical section data and original ground data are used as information including a five line profile. The design template information may in turn be used in the quantity computations program above, to compute volumes and slope stake reference information.

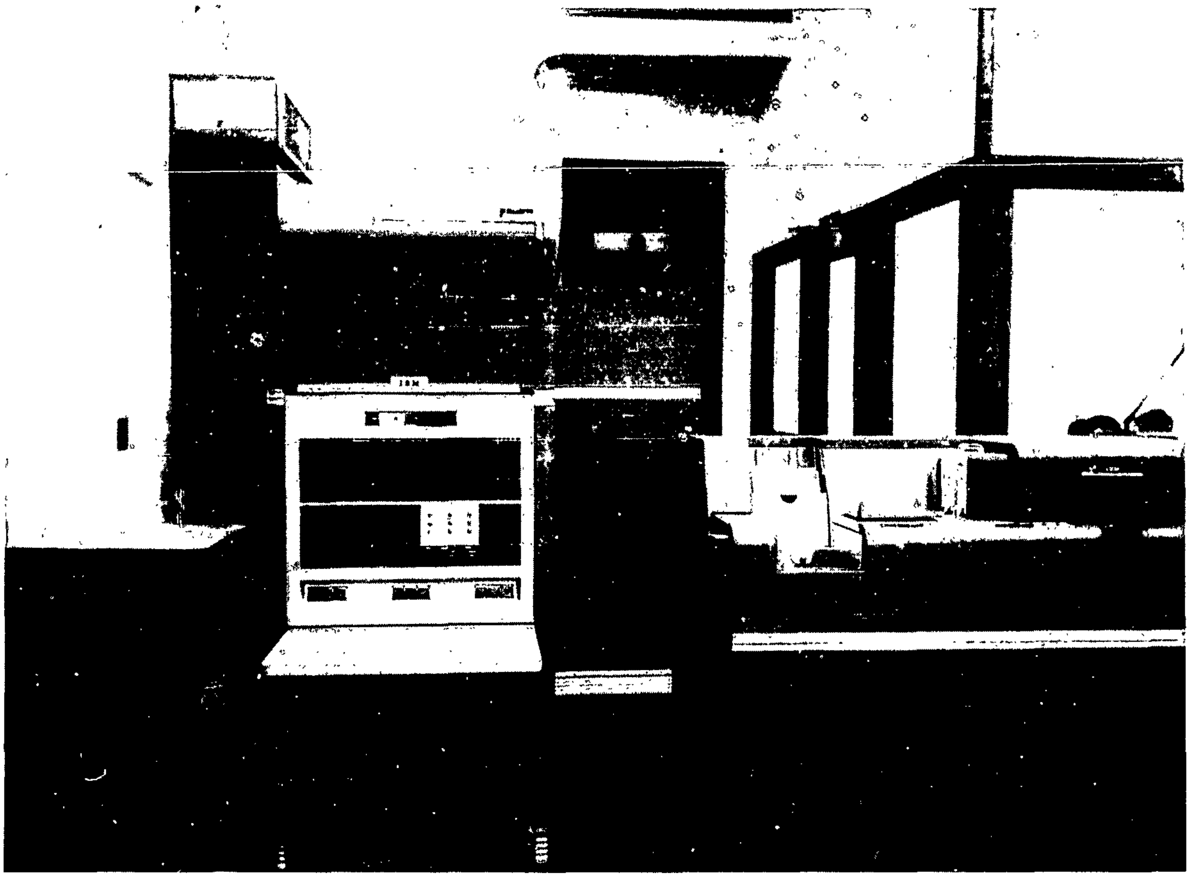


Photo by U.S. Army Engineer District, Omaha

The program computes the profile grade for a highway including verticle curve corrections. The input data consists of the P.I. stations, elevations, and length of verticle curves.

U.S. Army Engineer Supply Control Office

Located at 410 North Broadway, St. Louis, Missouri, the system with drum, tape and cards, is used for integrated stock and fiscal accounting.

Stock Accounting

Processing world wide customer demands and supply transactions in such a manner as required to maintain individual item stock balances, on a consolidated accountable property record, on all Engineer items stored within the continental United States.

Financial Inventory Accounting

Provides the monetary values of issuance, receipts and adjustments, as recorded against stated inventory balances of the accountable property records into a directed pattern of reports.

Stock Fund Accounting

Compiles computed dollar values of Stock Fund inventory balances and transactions into a designated chart of accounts as required to maintain a "balance sheet type record" of the Engineer Section of the Army Stock Fund.

Customer Billing

The preparation of printed bills to customers for all reimbursable issues of inventory items. Computed requirements of organizations and units as prescribed in TOE's, T/A's or other governing directives. This involves file maintenance routine of constantly changing requirements by addition and deletion action.

Mobilization Reservation Requirements

A process of compiling projected inventory requirements of individual item needs based on various degrees of mobilization.

World Wide Asset Data

An accumulation of statistics relative to the quantity, location, condition and net worth of all inventory items.

Integrated Supply Control of Minor Secondary Items

The process of measuring requirements against known assets for purposes of projecting a supply position and signifying actions required such as procurement, excesses, etc.

Item Identification and Cross Reference Files

Describing for Supply Control purposes, the item name, description and characteristics in the detail necessary to adequately inform potential customers of items available.

Photo by U.S. Army Engineer Research & Dev.Laboratories

U. S. Army Ordnance
Located in Bldg. 109-1, Inventory Control Division, Field Services Group, Philadelphia, Pa. The system with drum, core, and tape storage and tape and cards input-output, is used for daily updating National Availability Inventory Records, requests for material, catalog changes, determination of requirements, computation of digital levels, distribution and redistribution of stock, financial inventory accounting report, demand, issue and returns summaries, stock status reports, computation of basic loads, maintenance and usage of application file, in stock, technical service excess and disposal reports, file maintenance, and procurement status.

U. S. Army Ordnance
Located in Bldg. 353, Feltman Res. & Engineering Laboratories, Picatinny Arsenal, Dover, N. J. The system with drum and cards, is used for Interior Ballistics (burning-rate studies and projectile-propellant dynamics), (3-degree of freedom trajectories, inertial fuzing studies, and stability calculations), (lethal area calculations and systems analyses), design calculations, and use terminal ballistics data reduction.

U. S. Army Ordnance
Located in Bldg. 10, Watervliet Arsenal, Watervliet, New York. The system with drum and cards is used for research and engineering, labor control, payroll and leave accounting, and cost accounting.

U. S. Army Ordnance
Located in Bldg. 362, Anniston Ordnance Depot, Anniston, Alabama. The system with drum, disc, cards, tapes, cores, and typewriters is used for Ordnance Corps Distribution Depot, general supplies secondary items stock control (availability edit and item accounting) and related Financial Inventory Accounting Activities.

U. S. Army Philadelphia QM Depot
Located at 2800 S. 20th Street, Philadelphia, Pa. The systems are used for drum, card, tape, RAMAC, typewriter systems, payroll, cost reporting, factory production, procurement on-order, national inventory control, inventory updating, sales and billings, requisition and extract processing, cataloging, supply management, and retail requirements studies.

U. S. Army Richmond QM Depot
Located at Richmond, Virginia. The systems are used for card, tape system, the card, tape, RAMAC, fund accounting, depot maintenance program, army field stock control system, memorial, motor vehicle, special application, FIA Stock Fund, supply control, civilian payroll, stock accounting, national stock control, supply catalog, cost accounting, troop requirements.

U. S. Army Signal Corps School, ADPS
Located at Squier Hall, Room 178, Fort Monmouth, N. J. The drum, core, disc, tape cards, typewriter, is used for the training of Staff Officers,

Photo by U. S. Army Engineer Supply Control Officer.

instruction to all Signal Corps Officers, demonstrations to all classes showing capabilities of ADPS, training of Enlisted Programmers and Console Operators, and for the testing of possible programs to be used in the Army.

U. S. Navy Service Center

Located on the 2nd Floor of the Navy Service Center, Washington 25, D. C., the drum and card system is used for payroll, work measurement, labor distribution, lunar dynamics for the Naval Research Laboratory, and electronic production capabilities statistics.

U. S. Naval Air Development Center

Located at the Aeronautical Computer Laboratory, Johnsville, Pa., the drum, core, tape and card system is used for scientific computations and scientific data processing.

U. S. Naval Avionics Facility

Located in Indianapolis, Indiana, the drum, core, card and tape system is used for systems studies, error analyses, calibrations and data reduction.

U. S. Navy Bureau of Naval Weapons

Located in Temporary "W" Bldg. Rm. 1W09, 18th & Constitution Ave., N.W., Washington 25, D. C., the drum, card, tape system is used for production control, engineering calculations, research calculations, and statistical analysis.

U. S. Navy, New York Naval Shipyard

Located at Brooklyn 1, New York, the drum and card system is used for payroll, direct labor budget, interim cost, budget vs actual, daily report of costs, weekly and cumulative performance report, pipe stress analysis, tank capacity tables, propulsion shafting.

U. S. Navy, Portsmouth Naval Shipyard

Located at Portsmouth, New Hampshire, the drum card system is used for payroll, personnel, cost accounting and control, production planning and control, and scientific and engineering.

U. S. Navy, Puget Sound Naval Shipyard

Located in the Puget Sound Naval Shipyard, Bremerton, Washington, the drum card system is used for payroll (both hourly and per annum rates) including leave (sick and vacation absences) and savings bonds, direct labor budget (man-hour estimates versus actual), design and engineering, and workload forecasting (both short and long range).

U. S. Naval Supply Center

Located in Bldg. 211-3, Data Processing Dept., Oakland, Cal., the drum card system is used for updating, stock status balance cards for inventory control system, civilian payroll, U. S. Savings Bond

Photo by U.S. Army Philadelphia Quartermaster Depot

accounting for civilian personnel, calculation of EAM rental payment, and sundry management reports.

USAF, Headquarters, OCAMA

Located at Tinker AFB, Oklahoma, the drum-tape system is used for: commodity class property accounting, method of controlling material by AMC supply depots to worldwide AF activities, maintenance contractors, and other military services. Provides data which enables AMC to administer a timely, accurate and effective supply logistics system. Encompasses item accounting, providing inventory position and various products for effective management of serviceable, reparable, and excess material. Provides by-products which are the basis for dollar accounting and management of AF assets, inputs to other systems for requirements computations etc.

Base class property accounting - method for controlling material to support AMC internal depot functions and tenant organizations. System provides data required to enable supply components to administer timely, accurate, and effective material support. Otherwise same as commodity class property accounting application.

Maintenance engineering management material control - integrated management system based upon data which measures and evaluates actual performance against predetermined standards for labor, material and overhead. Consists of (1) work measurement system under which engineered labor standards are developed and maintained and which provides for comparison of standard hours with actual labor hours used to perform the work; (2) production control system which provides for planning, scheduling and controlling the application of manpower, material and facilities for the accomplishment of given workload requirements in the depot maintenance shops; and (3) the standard cost-accounting system, which provdes for the accumulation and analysis of both standard and actual dollar costs for labor, material, and overhead identified to the organizational unit which best exercises direct control over the cost elements.

USAF Air Material Command

Located at Bldg. 33, Bay C, Olmsted Air Force Base, Penna., three drum-core-tape-card systems are used for: prime and base class stock control and distribution.

All items stored at Hq MAAMA are recorded on tape in Class Code, stock number and account sequence. These tapes are called Master Balance Tapes. Action processed through the Supply System such as; shipment,

Photo by U. S. Army Watervliet Arsenal

receipts, inventory adjustments, transfers, etc., are processed daily to up date the master balance records. The following output products are generated when processing supply actions: transaction registers, shipping documents (104P1 & 104P3), inventory accounting monetary, material cost, stock fund, balance cards (category I & II only), inventory adjustment registers.

Each month the daily transaction registers are consolidated and consumption for each item is recorded. At stock balance reporting time (every 90 days for Hi-Valu and every 180 days for Category II & III) consumption qty is consolidated and selected from tape by item. Also at stock balance reporting time the assets stored at MAAMA are selected from the master tapes. The consumption cards and assets cards are used to prepare the stock balance and consumption report.

Every week stock list changes are processed against the master balance tape. This includes stock number changes, unit price changes, procurement source code and expendability-repair cost code changes and unit of issue changes. These changes are generated from USAF stock list catalogues.

IAM Reconciliation: This program utilizes M/B tape as input. The output is A/F and/or FSC 20 word record by item, with dollar value extended, total dollar value by account and PSC and overall total dollar value by class.

USAF, Air Materiel Command, Asst. for Data Services, Comptroller, these are used to compute the 90 day requirements and 30 day supportability. Products from this tape are: file maintenance to the master tape such as additions, deletions, changes, special requests and stock list changes, purge and transfer list, unidentified item list, AMC 550 Requisition cards, 30 day supportability list, parts shortage list.

A quarterly report to show maintenance if their replacement percent in the material standards is a realistic figure. Report consists of actual material, end item production, production count and material standards.

A master tape compiled daily to make a monthly report on the cost of all material used by maintenance.

A master tape inventory balance which is updated daily by transactions. Stock list changes are processed weekly against this tape. Transaction registers, 550, 550, a card etc., are made daily from this tape.

A tape made quarterly to update the unit cost in the material standard master tape. Re-price tape

Photo by U.S. Air Force Directorate of Statistical Services

USAF Mobile Air Material Area

Located at Brookley AF Base, Mobile, Alabama, the drum-core-tape-card system is utilized for: stock control and distribution system, maintenance management system, inventory accounting (monetary) system, unit authorization listings, mechanized civilian payroll system, PCAM utilization reporting program, test validation system. These include the processing of Air Force property records for which MOAMA has world-wide responsibility, the processing of MOAMA's maintenance-engineering management system, a program developed for controlling equipment material to operate the base, a program that computes civilian pay and leave for preparation of civilian leave and earning statements, checks, and printing of bonds, a program that computes the PCAM machine utilization, and a program for validating test scores for civilian personnel.

USAF Air Materiel Command

Located at Bldg. 33, Bay C, Olmsted AFB, Penna., the system is used for implementation of a mechanized payroll system, providing for preparation of civilian payroll checks, bond issuance program and leave and earning statement is scheduled for December 1960.

Fields of application include: this program utilizes the IAM daily corrections for IAM daily transactions as input cards. The output cards are daily summary cards and financial detail cards. The summary cards dollar value condition is controlled by the posting control; the group number by weapons code, IAM code, account code.

This program utilizes the daily summary cards as input. The output cards are IAM periodic summary cards. The dollar value is summarized by PSC within account, within IAM for each class.

This program utilizes the IAM periodic summary cards as input. The output cards are IAM monthly summary cards and IAM monthly line cards. The monthly summary dollar value is summarized by IAM within account, within PSC, within class symbol sequence. The monthly IAM line card is summarized by IAM.

From IAM opening balance cards and IAM monthly summary cards, this program prepares the closing balance cards for the month. The opening and closing dollar values are summarized by condition and by condition within PSC for each class and storage site.

From monthly summary cards for the quarter, this program prepares one card showing dollar value for

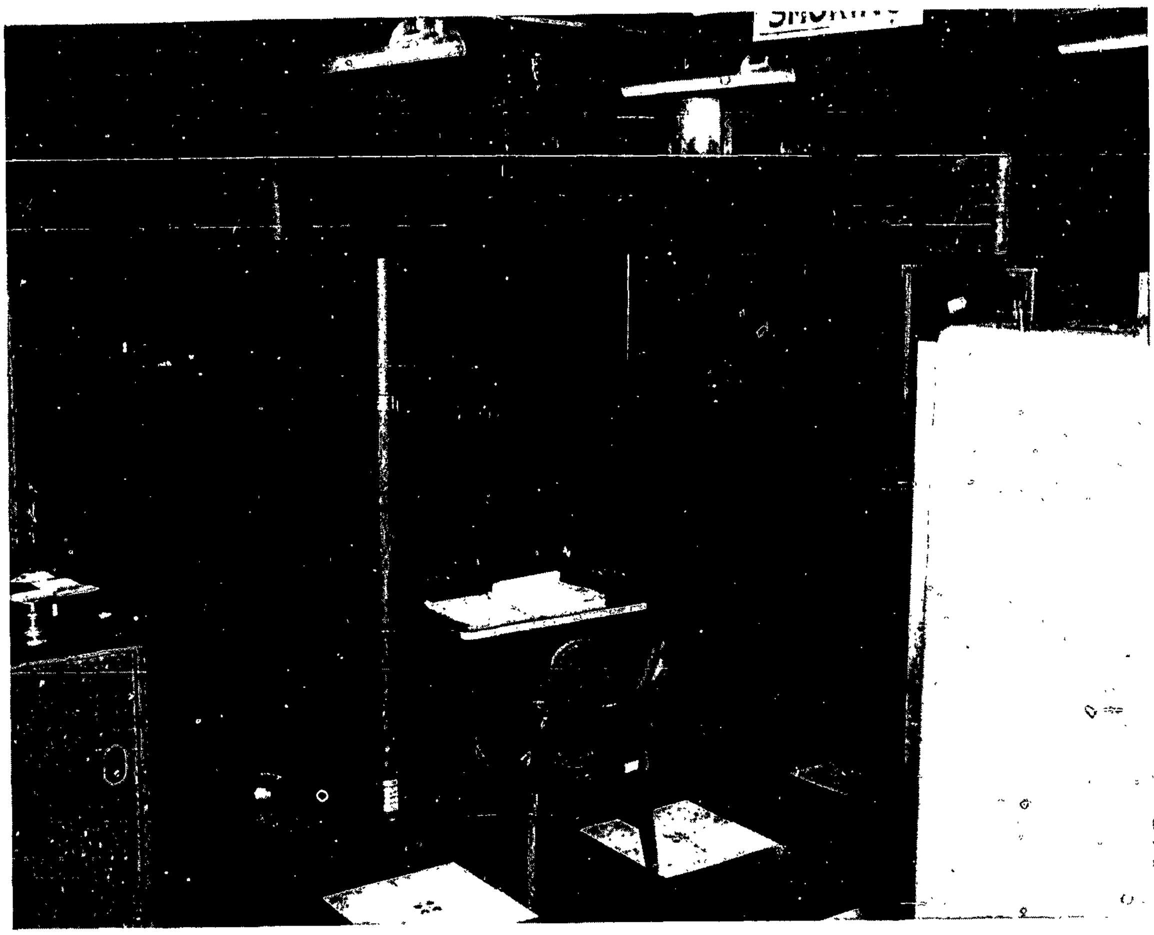


Photo by U.S. Air Force Mobile Air Materiel Area

the quarter for all items which have common class symbol, PSC, ownership account, condition code and IAM code

This program utilizes IAM opening balance and IAM monthly summary cards, for the quarter, as input cards. The output cards are quarterly supply summary cards and AMIL summary cards. The quarterly supply summary dollar value is summarized by condition, within IAM, within account, within reporting depot, within controlling depot, within class symbol. AMIT summary dollar value is summarized by fields controlled by account and condition.

This program utilizes MPA balance cards as input. The output is IAM reconciliation cards by item, with dollar value extended, all "Q" accounts have only service value extended.

This application governs the accurate accumulation and reporting of on-hand assets and consumption data to provide essential information to AMA's, depots, and bases under the AF logistics concept. These reports determine the gross future needs of the Air Force, the items the Air Force can expect from repair, and the stock availability. The information provided by SB&CR's is as follows: Actions that have occurred during a reporting period (issues, condemnations, reparable generations, serviceable returns from overhaul, etc); quantity of assets on hand and their condition; and, location of assets (on-work-order, intransit, reparable shipments, etc).

This program takes projected programming data from Hq., USAF (received on classified computer tape) and produces Management reports for the Plans and Program Office at Hq., MAAMA (MAFD). That office, in turn, reflects the aircraft flying hours and engine flying hours by type, model, series of MAAMA prime aircraft and MAAMA prime engines for three fiscal years on a projected basis.

This program deals with items as related to specific types, models, and series of aircraft. It applies the quantity per assembly (quantity of this item which is installed on a specific aircraft) to the percentage of application to compute a factor. The percentage of application is the percentage of this particular type, model, and series of aircraft which uses this item, as related to the total number of this type, model, and series of aircraft in the Air Force. The factor is applied to the past and present projected flying hour program data to arrive at the installed

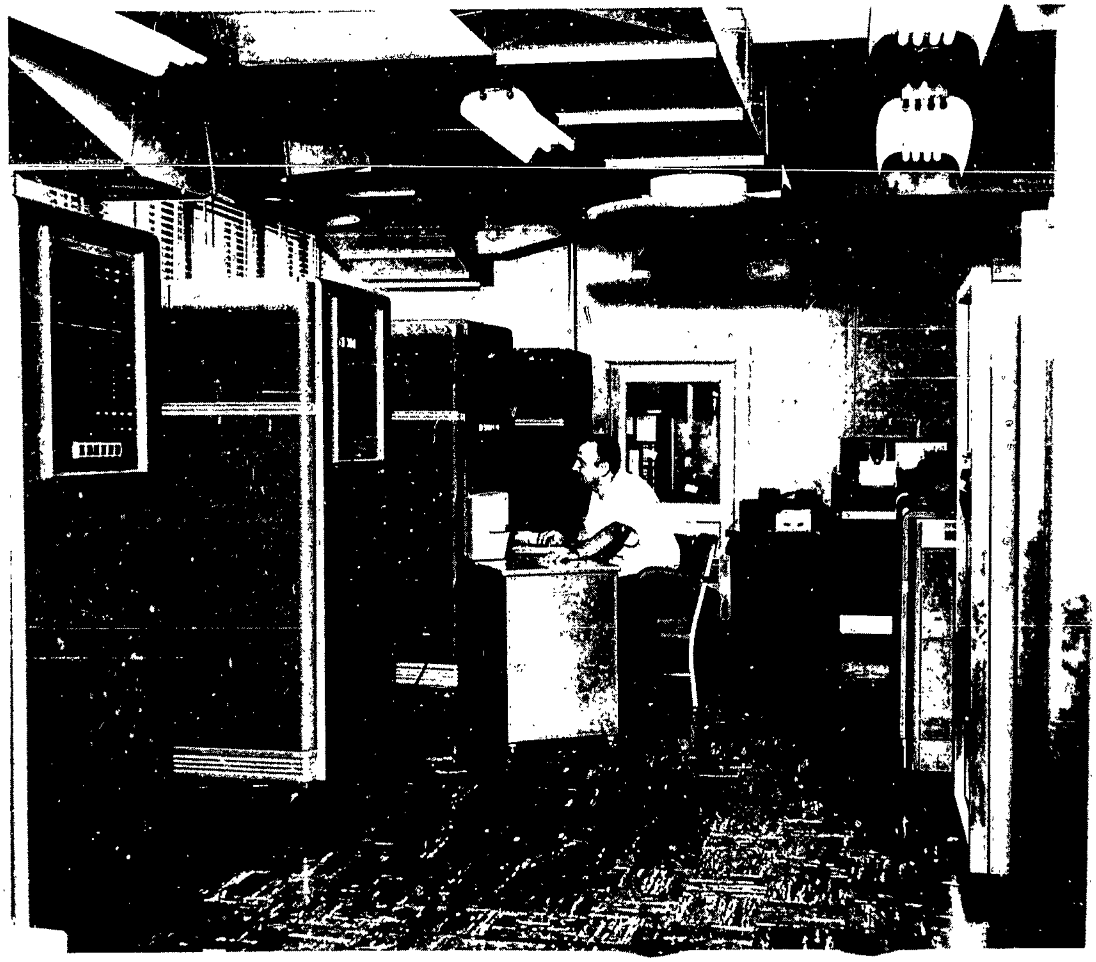


Photo by U. S. Air Force Patrick AFB

flying hour programs for each particular requirement, i.e., stock level hours, repair cycle hours, etc. In a later program various factors are applied to these hours in determining the requirements for cost category II recoverable items.

USAF Mobile Air Materiel Area

Located at Brookley AFB, Alabama, the drum-core-tape-card system is utilized for: stock control and distribution system, maintenance management system, inventory accounting (monetary) system, unit authorization listings, mechanized civilian payroll system, PCAM utilization reporting program, test validation system. These include the processing of Air Force property records for which MOAMA has world-wide responsibility, the processing of MOAMA's maintenance-engineering management system, a program developed for controlling equipment material to operate the base, a program that computes civilian pay and leave for preparation of civilian leave and earning statements, checks, and printing of bonds, a program that computes the PCAM machine utilization and a program for validating test scores for civilian personnel.

USAF San Bernardino Air Materiel Area

Located at Norton AFB, California, the drum-card system is used for: Maintenance Support and Maintenance Management, includes data processing for flow of material programming data; for the computation and forecasting of items of supply required to support current operations and programs; for inventory, utilization, and status of aircraft engines and missiles, for such functions as stock control, inventory warehousing, transportation, requisitioning and back order procedures; for all identifying and cataloging operations such as Federal Conversion Program, AF stock lists, D/A cross reference index, etc; for inventory, utilization, accounting and status of such property as medical-dental, clothing, ammunition, petroleum, oils and lubricants.

Maintenance Support and Maintenance Management. Includes data processing concerned with the collection and reporting of labor and production statistics involving work measurement, labor distribution materiel standards and projection; includes data processing for product improvement system such as material failure and "UR" reporting.

Financial Management and Accounting System (includes Mechanized Civilian Payroll System), includes data processing concerned with reports developed for the purpose of projecting budget requirements and financial plans; preparation and maintnenace of reports pertain-

Photo by U. S. Air Force Patrick AFB

ing to monetary value of items in stock and in use; maintenance and operating costs of real estate facilities; preparation and maintenance of reports reflecting cost data for both labor and material for all functions; preparation and maintenance of reports reflecting obligation, commitment, expenditure, and status of funds; cost of public work programs and construction activities; preparation of expense report, punched card check program, check reconciliation and other similar processing and reporting activities; and processing of other reports reflecting accounting or financial data for such functions as general accounting, expense accounting, clothing and commissary accounting.

Mechanized Civilian Payroll System (Authority: AMC Manual 171-1, Volume II, Chapter 369-51 and AMC Letter 25-112, dated 29 October 1957). This system provides for the maintenance of punched card pay records for all employees at Norton AFB and within the Hq., SBAMA. Bi-weekly time and leave records are processed against this master file and time and leave records are updated, employees' pay is computed and pay checks and leave and earning statements are published for each employee. As additional system benefits, year-to-date records of payments are kept and labor distribution data is created for cost accounting purposes.

Equipment Management and Data Processing Production Control: includes data processing required in the compilation of unit allowance list and base allowance list; effort required in maintaining the files and preparation of the actual lists and reports; data processing for inventory, utilization and status of vehicles other than aircraft, electronics and communications equipment, and data processing equipment.

USAF, Hq., AFSWC, Kirtland AFB

Located at Kirtland AFB, Bldg. 499, New Mexico, the drum-card system is used for inventory accounting monetary, appropriations accounting, supply inventory control and maintenance exception time accounting.

USAF APGC (PGCS) Eglin AFB

Located in Bldg. 100, Room 108, Eglin AFB, Florida, the drum-card system is used for: automatic processing of supply transactions, equipment control, personnel, financial services, and miscellaneous applications.

USAF Hq. Directorate of Statistical Services, APO 633, N. Y., N. Y.

Located in Wiesbaden, Germany, the drum-core-tape-card system is used for enlisted military personnel accounting and reporting, officer military personnel accounting and reporting, civilian personnel accounting and reporting, manpower authorization system, intelligence data analysis, ground electronics installations, and medical stock fund reporting.

Photo by U. S. Air Force Special Weapons Center

USAF Hdqs., MATS
Located in Bldg. S-920, Scott AFB, Illinois, the drum-core-tape-card-typewriter system is used for personnel accounting, manpower and organization, materiel, and operations and traffic.

USAF Hdqs., Pacific Air Force
Located in APO 953, San Francisco, Cal., the drum-core-tape-card system is used is Statistical Services for: personnel application (Military) maintenance of complete personnel data on all military personnel assigned to PACAF organizations. Programs include updating of files, error determination, preparation of all mechanized personnel reports required by USAF and PACAF. CMOP application. Maintenance of complete authorization data for unit manning documents of units assigned to PACAF. Programs include updating of files, error determination, preparation of authorization reports required by USAF and PACAF. Miscellaneous. Programs in accounting, UAL and MRAL. These prepare cost reports required by USAF and PACAF. Intelligence applications.

USAF Hdqs., PACAF A-3 Directorate of Control
Located in APO 953, San Francisco, Cal., the tape-drum-core-card-typewriter system is used in Directorate of Control for operations and intelligence.

USAF ROAMA Griffiss Air Force Base
Located in the Depot Supply Bldg. No. 1, East Wing, Griffiss AFB, the drum-card system is used for payroll, personnel, mechanized property accounting and inventory accounting management.

USAF Hdqs., Strategic Air Command
Located in the Offutt AFB, Nebraska, the drum-tape-disc-card system is used for command military personnel accounting (detail command personnel files are centrally maintained and all USAF and SAC required reports and information products are developed there from) and command manpower and organization authorization accounting (command authorization information files are centrally maintained and used to develop all reports and information products, including publication of all unit manning documents).

USAF 2709th AF Vehicle Control Group
Located at 3300 Jackson Ave., Memphis 2, Tenn., the drum-card system is used for stock control and distribution - inventory management, in support of vehicle reporting and control, mechanized 650 payroll system, in support of project count - wall to wall inventory, and in support of work measurement.

NASA Flight Research Center, Box 273
Located at Edwards, Cal., the drum-card system is used for aircraft flight data reduction, missile trajectories, theoretical heat transfer and supersonic flow, and cost accounting.

U.S. Dept. of Agriculture, Commodity Stabilization Service, USDA
Located at the Evanston CSS Commodity Office, Evanston, Ill., the drum-card-tape-printer system is used for the processing of price support loan and purchase transactions for the 19 states served by this office. This application includes computation of loan and purchase transactions, preparation of settlement statements with farmers and producers, and recordation of accountability for these transactions - approximately 111,000 transactions are processed annually. It is also used for the preparation of precomputing invoices covering warehouse charges due to grain elevators - approximately 4,000 invoices are prepared monthly, and for the preparation of settlement statements of warehousemen covering quantity and quality differences on grain delivered as opposed to ordered for delivery also covers final settlement for warehousing charges - approximately 2,000 settlements are processed per month.

Photo by U.S. Air Force 2709th AF Vehicle Control Group

California Division of Highways

Located at 1120 "N" Street, Sacramento, Cal., the drum-card system is used for engineering computations, statistical applications, and traffic routing and assignment.

U.S. Dept. of Commerce, Coast and Geodetic Survey

Located in Room 3009, Dept. of Commerce Bldg., Washington, D. C., the drum-card system is ~~used for~~ scientific applications, including adjustment of surveys (triangulation and traverses), reduction of magnetic observations, adjustment of aero-triangulation, gravity vector components, calculation of flight bearings for check VOR facilities, and for fiscal and budget applications, including payroll and cost accounting.

U.S. Department of the Interior

Located at Denver Federal Center, Bureau of Reclamation, Denver, Colorado, the drum-card system is used for engineering and scientific computations for problem arising in the investigation, design, construction, and operation of reclamation projects.

U.S. Treasury Dept., Internal Revenue Service

Located 10th and Constitution Avenues, Washington, D. C., there are three idential systems at Lawrence, Mass., Kansas City, Mo and Ogden, Utah. These are drum-card systems used for mathematical verification of income tax returns, computation of account balances and interest, computation of installments of estimated tax, payroll computations, computation of personnel and machine utilization reports, and computation of man-hour distribution reports.

American Airlines

Located at 100 Park Avenue, New York, New York, the drum-card system is used for commercial payroll accounting, general accounting, statistical studies, and operations research problems.

Bridgeport Brass Company

Located at the Ground Floor, 30 Grand Street, Bridgeport 2, Conn., the drum-card system is used for payroll and payroll statisitcs; sales statistics, including customer sales reports, cost of sales reports, and tax reports; inventory, including mill products finished goods. housatonic avenue plant process, venetial blind strip and components finished goods; and cost accounting at the Housatonic Avenue Plant.

Convair, A Division of General Dynamics

Located at Convair, Fort Worth, Texas, the system is used for Material Project Status - Semi-weekly File Maintenance. Requires approximately 35 hours of 650 time weekly. Semi-weekly material transaction activity, together with applicable material item balance summary cards at the project level, are processed into the 650 to produce:

category and contract transfer detail activity cards, procurement notice detail activity cards, procurement change notice detail activity cards, procurement notice balance reporting cards, contract code error detail activity cards, purchase parts below minimum reporting cards, internally initiated project transfer activity updates the item balances at the project level without producing output detail activity cards, daily transaction activity detail cards priced at standard unit price, updated material item balance summary cards representing effect of input transaction and also internally initiated transactions. Material Project Status Report - Dollars, Monthly:

Requires approximately 21 hours of 650 time monthly.

Photo by U.S. Bureau of Reclamation Denver

Material item balance summary cards at the project level, together with applicable master material cards containing standard unit price, realization factors, and class/DMS codes, are processed as of accounting closing to produce priced detail output deck reflecting standard value of the on hand, on order, open requirements (or order point), and status balances. Commercial/Production Consumption Minimum -Order Point and Economic Order Quantity Calculation, Monthly.

Requires approximately 28 hours of 650 time monthly. Card decks representing current material item status, minimum - order point master data, and prior six month's usage are combined at the material item level and processed into type 650 to produce: update usage history, order point quantity adjustment detail cards, procurement notice detail activity cards, as applicable, reflecting recommended quantity to procure, procurement notice balance reporting card, on-call sub-purchase order detail activity cards, special notification detail cards, updated material item balance summary cards, commercial project status dollars cards, priced at standard unit price. Material On-Call Sub-Purchase Order, Monthly.

Requires approximately 2 hours of 650 time monthly. Material on-call sub-purchase order detail cards, together with applicable on-call vendor name and address masters are processed to produce material on-call sub-purchase order vendor name and address detail cards. Material Sub-Stores Project Status, Monthly File Maintnenance. Requires approximately 6 hours of 650 time monthly, material tranaction activity pertaining to sub-stores, together with applicable material sub-stores item balance summary cards at the sub-stores level, are processed into the 650 to produce:

Sub-stores transfers, detail activity cards to replenish sub-stores, sub-stores zero stock notice detail cards, sub-stores special notification detail cards, cashed sub-stores transfer detail activity cards, updated material sub-stores item balance summary cards representing effect of input transactions and also internally initiated transactions. Material Detail Parts, Shop Order Requisition Allocation, Monthly: Requires approximately 2 hours of 650 time monthly, card decks representing material cashed requisitions and shop order work order details, cashed requisition and shop order work order group summaries, and requisition master header card data are combined and processed into Type 650 to produce allocated work order summaries cards.
Coding Final Labor Distribution, Weekly: Requires approximately 1-1/2 hours of 650 time weekly, this application assigns account numbers and sub-account numbers based on work order numbers and charged department. It also accumulates tenths of hours to develop "Whole Hours" totals.
Common Cost Allocation, Monthly. Requires approximately 1 hour of 650 time monthly. Unidentified hours worked are allocated to work order numbers assigned to comon cost distribution. Allocations are made based on the percentage of unidentified hours to the total hours charged to common cost work order numbers. Hourly Retirement Calculations, Yearly. Requires approximately 5 hours of 650 time yearly. Current year's retirement benefits (base and excess) are calculated based on hourly rate, hours worked, birth date, and hire date. Total retirement benefits are calculated to date. Master FR/PEO Schedules, Bi-weekly. Requires approximately 1/2 hour 650 time per schedule. Schedules show the estimated start and completion dates as forecasted by the Facilities Department in comparison to the actual dates recorded by the various departments responsible for completion. The schedules serve management as a guide to sequencing the start of jobs and close follow-up.

Photo by Bridgeport Brass Company Jack Stock Studio

The 650 is used for this job in order to take advantage of the "Selective Field" key punching technique, whereby only the individual changes need be key punched rather than a complete line entry.

Vendor Quality Performance Rating, Quarterly. Data regarding material and/or parts received from vendors, plus inspection rejection data, are accumulated perpetually. Every three months the previous twelve months's data is calculated, using probability factors to produce: ratings by vendor within a material group, ratings by product type, quality ratings based on effectiveness. The ratings developed by 650 are used as a guide to buying from vendors.

Quality Control Engineering Statistics, as Required. Requires approximately 1-1/2 - 2 hours of 650 time per week. Statistics are calculated using IBM 650 library programs and the "Bell Interpretive System." These programs are used in areas of process development, process analysis, process modification, process control, and departmental quality analysis. Calculations include: simple correlation analysis, multiple correlation analysis, frequency distribution, averages, and standard deviations, significance tests, average range charts, special analysis using "Bell" programming. Sub-Assembly Shop Ordering-Preparing of Travelers, as Required. Cards are pulled from manufacturing parts list deck by segment and lot as required. These cards are merged with a major component schedule (in punched card form(by item and indenture. The 650 determines and punches into sub-assembly travelers: manufacturing span time, start and completion dates, total quantity ordered, work order number, ship number. Control Assembly Parts List - Engineering Release, Daily. This system employes the "Selective Field" key punching method of up-dating a file of over 650,000 cards on a daily basis. Red pencil changes are entered on parts lists by engineering parts list group. Only the red pencil entries are key punched into "Change" cards and are matched to the particular line entry by a line serial number. In some cases, a single change card may be used to correct several or even several hundred line entries. Debit and credit material cards are punched where the change affects material ordering. Control totals are prepared manually and balanced mechanically.

Tennessee Eastman Company

Located in Kingsport, Tennesee, the drum-core-card system is used for equipment design (includes pipe stress analysis, B.W.R. equation of state, network flow analysis, pressure vessel and shell head, heat exchanger, plate to plate analysis, and vapor liquid equilibrium), analysis of control laboratory, experimental, and historical data (includes evolutionary operation, time trend box method, Yates analysis of variance, forecasting by exponentail smoothing, interplaner spacing of HKL plane, differential fourier synthesis, etc.), and commercial uses (includes construction work load, sales analysis exception basis, sales accounting summaries, operating labor scheduling).

The Emerson Electric Mfg. Co.

Located at 1567 Salzman Ave., Wellston, Mo., the system is used for engineering and scientific calculations together with data processing related to engineering tasks. Some specific items are missile trajectory calculations, heat transfer, aircraft-missile intercept, prediction of failure rates of complete electronic system and maintaining files of failure reports for reliability evaluation.

Cleveland Engine Plants, FOMOCO

Located in Cleveland Engine Plant No. 2, Brookpark, Ohio, the system is used for Payrolls and Labor, timekeeping records, hourly payroll reports, salary payroll reports, labor distribution, overtime equilization, personnel records, statistics. Production Control, computation of net requirements

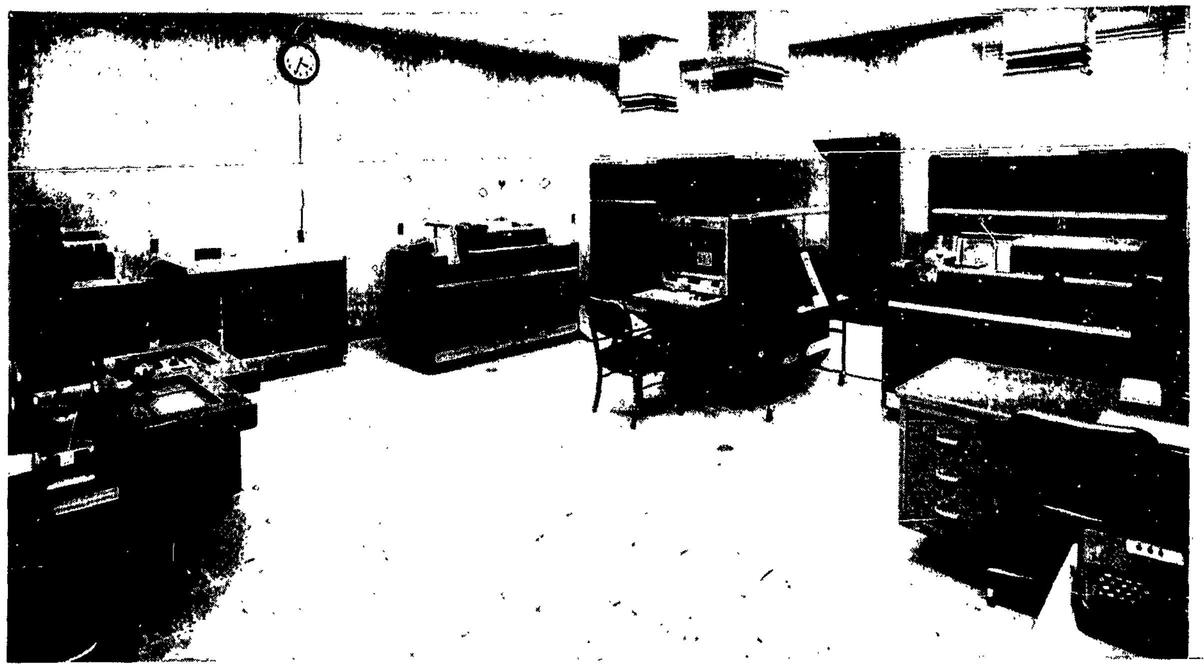


Photo by Ford Motor Company APS and ERO

releasing, receipts, shipments, cycle count adjustments, inventory planning, cycle count control, productive mat. inventory, perished tooling. Cost Accounting, scrap analysis, Mfg. expense ledger, perpetual inventory, accounts payable, accounts receivable, accountable document control, purchase priority variances, direct labor performance, cost of sales production reporting.

Controllers's Office, Ford Motor Company

Located in the Controller's Office, Box 494, Dearborn, Michigan, the system is used for accounting, production control, quality control, plant engineering, and personnel.

Ford Motor Company, Advanced Product Study and Engineering Research Office

Located in the Scientific Laboratory and Research Bldg., Engineering & Research Staff, Dearborn, Mich, the system is used in computation relating to engineering design studies, largely in the field of mechanical engineering, and concerned with projection of system performance, stress analysis, vibration studies, gear design, vehicle suspension design analysis, structural rigidity, test data reduction, etc. Various "Basic Research" programs in atomic structure, heat transfer, magnetic properties also use this computer.

Harrison Radiator Division, General Motors Corporation

Located in Lockport, New York, the system is used for heat exchanger design program (main program). Representative sub-routines of this program are, plate fin geometry for cross flow, temperature check, core weight and volume, and regenerator and oil cooler modifications. Curve fit-quadratic (a series of six quadratic equations to plot the points of a curve). Analysis program, (a series of geometric programs to allow for computation from basic data to finished result of from finished result back to basic data).

Institute for Defense Analyses

Located in Room 1E871, Pentagon, Washington, D.C. The system is used for war-gaming procedures for evaluating weapons systems, cost accounting,and damage assessment problems.

Littauer Statistical Laboratory

Located at 94 Prescott Street, Cambridge, Mass. the drum-core-card-tape system is used for statistical problems such as frequency distributions, correlations, regressions, factor analyses,(principal axis, verimax, and oblimin rotations) sociograms, etc.

Michigan Bell Telephone Company

Located on the 1st Floor, 23500 Northwestern Hwy., Southfield, Michigan, the system is used for payroll (24000 employees), util. and cost reports of IBM equip., non-management wage survey, com'l work vol. meas. plan, annual mortality studies, general sales results, general planning forecasts (trunk est., etc.), shifting seas. var. and calendar shifts, linear correlation of time series, traffic point to point study, directory sales results and commisions, traffic Detroit Area Trunk Estimates, trunk adm. weekly results, dial loading report, message unit detail billing study, coil collection scheduling, and traffic observing results.

Olin Mathieson Chemical Corporation

Located at 275 Winchester Ave., New Haven, Conn., the system is used for fuels performance calculations, multi-component equilibria, free energy, isentropic expansion, flame temperature, mollier diagram, mechanical and thermal stresses, statistical analyses, regression analyses, planned experiments, least squares curves, theoretical crystal growth, heat transfer, production machine speed trables, thermocouple temperature tables (Callendar Equipment).

Photo by Ohio Oil Company

The Prudential Insurance Company of America, Electronics Research Division

Located at Newark, New Jersey, the system is used for ordinary insurance billing and accounting, agency records and debit insurance, district agencies payroll, mortgage loan accounting, valuation-actuarial, actuarial - statistical calculations.

RCA Service Company, BMEWS Project

Located at Griffiths Air Force Base, Rome, New York, the drum-card system is used for inventory control, reliability, monetary accounting, procurement, transportation, and engineering.

New York Stock Exchange

Located at 18 Broad Street, New York 5, N. Y.,the system is used for verification, clearance and settlement of security transactions-executed on the New York Stock Exchange. The operations facilitate the physical delivery of securities and payments of money related to security transactions. Services of S. C. C. are rendered to Clearing Members of the New York Stock Exchange and Member Banks of New York Clearing House Association.

Sun Oil Company

Located at the Marcus Hook Refinery, Marcus Hook, Penna., the system is used for refinery simulation to determine optimum method of operation, process calculation to establish operating conditions, chemical engineering design calculations, analysis instrument data reduction, and marketing statistical analysis.

Western Electric Company

Located at 77 South Wacker Drive, Chicago, Ill., the drum-core-disc-card-tape system is used for the preparation of payroll checks, distribution of payroll, analysis of deductions from pay, processing of cost and billing procedures, preparation of quarterly and year-end State, City and Federal Tax Reports, Pension Statistics and related payroll and deduction report data.

Colorado State University Computing Center

Located at Fort Collins, Colorado, plans to get an IBM 650 Summer 1960.

Columbia University

Located at Dobbs Ferry, New York, the drum-card system is used to assist theoretical and experimental research and for the processing of scientific data.

Cornell University

Located at the Dairy Records Processing Laboratory, Ithaca, New York, the computer and peripheral equipment are used to process monthly DHIA records for about 250,000 cows from 11 northeastern states. The computer is used about 50% of the time processing this material, 20% of it's time is spent doing routine analyses such as evaluating sires used in artificial insemination and preparing other research material to be distributed to the DHIA membership involved in the program. The remaining time is utilized in basic and applied research in quanitative genetic, this effects environment and management on dairy production and other analyses of a statistical nature.

Indiana University

Located at the Research Computing Center, Bloomington, Indiana, the system is used for almost all phases of University Research make use of the Center's facilities. The following are some of the major fields of research using the computer: astronomy: stellar interiors and stellar atmospheres. Chemistry: quantum mechanics, x-ray diffraction. Business and Economics: surveys of markets, executive games. Mathematics: numerical analysis. Psychology: mathematical model studies. In addition, the

Photo by Socony Mobil Oil Company, Incorporated

departments of Political Science, Sociology, and the School of Education make great use of the Center.

Marquette University

Located in the Computing Center, Milwaukee, Wis., the drum-card system is used for research problems from all fields of university endeavor and for student education in programming.

Stanford University

Located at the Computation Center, Stanford, Cal., the drum-card system is used for the range of interests of an academic community.

Syracuse University

Located at the Computing Center, 112 Hinds Hall, Syracuse University, Syracuse 10, New York, New York, the system is used for Mathematics: procedures for solving high order complex polynomial equations. Chemical Engineering: explosion pressure calculation. Economics: evaluation of Cobb-Douglas Production for USA and USSR Data. Industrial Engineering: shop scheduling study (Thesis). Industrial Engineering: Statistical Quality Control Study (Thesis). Education: predicition of reading skills. Civil Engineering: analysis of errors in aerial photogrametry. Electrical Engineering: effect of the presence of ferrite posts in waveguides (sponsored). Psychology: study of new ability measuring index (Thesis). Industrial Engineering: calculation of interest factors. Industrial Engineering: reliability of estimates in economics problems (Thesis). General Elect.: Probability of radar tracking of missiles (sponsored by General Electric). Chemical Engineering: study of the Van Laar Equation (Thesis). Niagara Mohawk: study to find optimum operation of a hydroelectric plant (sponsored by Niagara Mohawk). Business Statistics: study of production indices. Physics: relaxation rates. Mathematics: analysis of cosmic ray data (Thesis). Psychology: study of non-linear discriminant functions (Thesis). Elect. Engineering: mutual impedance between individual elements in a large antenna array (sponsored by Rome Air Development Center). Sociology: predicition of hospital prognosis from social factors. Niagara Mohawk: study of gas distribution and transmission systems (sponsored by Niagara Mohawk). Radio-Television: analysis of audience characteristics of viewers and non-viewers of an educational television program series, "Books and Ideas"-------Determination of factors predicitng television program success (sponsored by Schwerin Research Corp. of NYC). Psychology: juvenile delinquency study (sponsored by U. S. Office of Education). Smith Corona: Determination of sales quotas (sponsored by Smith-Corona). Bacteriology and Botany: wholesomeness of irradiated foods (sponsored by Army Surgeon General's Office). Education: verbal problem skills in arithmetic (Thesis). Sociology: analysis of community influence systems. Preventive Med. College of Med.: Toxoplasmosis study (sponsored by State of New York). Elect. Engineering: power loss study (sponsored by Niagara Mohawk). Elect. Engineering: study of examination techniques in electrical engineering. Elect. Engineering: study of interpretive coding scheme with reference to electrical engineering requirements.------preliminary study of linear arrays with non-uniform spacing. Elect. Engineering: Fourier Integral Transform Study (Thesis). Education: relation of selected non-intellectual factors to Over - and Under-Achievement in Several College Groups (Thesis). Pediatrics Dept. College of Med.: characteristics of autonomic nervous system function in new born and young infants (sponsored by the State of New York). Elect. Engineering: transformer rating (sponsored by Niagara Mohawk). Psychology: juvenile delinquency study (Thesis).

Photo by Socony Mobile Oil Company, Incorporated

Psychology: background factors and correlates of achievement motivation (Thesis). Elect. Engineering: near-zone antenna field synthesis (sponsored by General Electric). Traffic Commission: ordering of information provided by student traffic cards at S.U. Society of American Foresters, College of Forestry: study of education in forestry and related fields of natural resources management (sponsored by Society of American Foresters). College of Lib. Arts, Office of the Dean: study of the transfer student in the College of Liberal Arts. Elect. Engineering: antenna arrays (sponsored by Rome Air Development Center). Eckerlin and Klepper: study of moment distribution in connection with the design of new dormitory construction at Syracuse University (sponsored by Eckerlin and Klepper). Physics: optical modes in calcite and arafonite crystals (Thesis). Electrical Engineering: computation to obtain graphical representation of equipotential lines outside an elliptical electron beam (sponsored by NSF). Civil Engineering: photographic coordinate measurement errors and their effect on tilt and resection (Thesis). Special Education: Statistical study of results of series of verbal and non-verbal tests given to school children (sponsored). Dept. of Microbiology, College of Med.: population genetics study (sponsored by State of New York). Forest Management, College of Forestry: the predictive validity of two tests with forestry students at Oregon State College (Thesis). Physics: study of bubble chamber tracks (sponsored by AEC). Economics: income distribution (Thesis). Youth Development Center: a study of the characteristics of apprehended juvenile delinquents in Onondaga County (sponsored). Business Administration: management games. Univ. of Hawaii: analysis of sugar cane growth (sponsored by Hawaiian Commercial Sugar Company). Mathematics: study of prime numbers. Dept. of Chemical Engineering, College of Forestry: dilute solution properties of polymers (sponsored by Soc. of Am. Foresters). Mathematics: computational experiments with the conjugate gradient method and other related methods for the solution of systems of linear equations. Niagara Mohawk: evaluation of the place of nuclear power among the power-generating resources (sponsored by Niagara Mohawk).

The term "sponsored" indicates financial aid in part or in full from a source outside of Syracuse University.

Problems listed for Niagara-Mohawk, General Electric and Smith Corona indicate a cooperative arrangement between the Syracuse University Computing Center and the Syracuse Community as a whole. Computing time on our machine is provided occasionally for such companies for problems of a research (non-production) nature if time is available at no sacrifice to University users.

University of Houston

Located at the Computing and Data Processing Center, University of Houston, Houston 4, Texas, the drum-card system is used for education and research in all areas where a computer is useful.

Vanderbilt University

Located in Wesley Hall, Vanderbilt University, Nashville, Tennessee, the system is used in the research field by the physics, chemistry and astronomy and engineering students for calculations to be used in their theses. Various members in the science departments have used it for problems pertaining to private research work. The medical school has made some use of it, in particular the radioisotope section which uses a routine to interpret the information from their analyzer and calculate the amount of potassium in the human body.

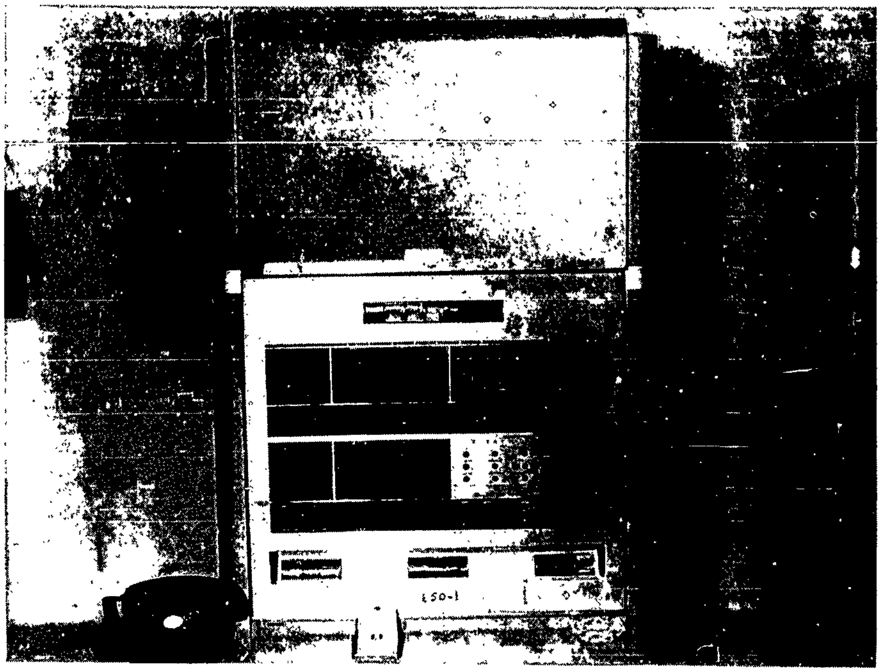


Photo by Western Electric Company, Omaha

The machine has been utilized more for statistical work than any other type of calculations. The psychology, sociology, and economics departments have been most active in this way.

For education the machines have been used in the conducting of classes in programming and computing for any interested members of the university community.

Yale University

Located at the Computing Center, 135 Prospect Street, New Haven, Connecticut, most of the work is done in physics and social sciences by staff members of these departments and by graduate students in these departments doing work toward their degrees. A drum-card system is used.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Decimal
Decimal digits/word	10 plus sign
Instructions/word	1
Instructions decoded	89
Arithmetic system	Fixed point (standard)

Floating point is an optional feature (2 digit character, 8 digit mantissa and sign)

Instruction type	One address

Modified to include location of next instruction

Number range $-10^{10} < a < 10^{10}$

Instruction word format

	1	2	3 6	7 10
Sign	Oper	Code	Data Address	Location of Next Instruction

Soap, Fortransit, assorted customer programs for general problems (utility routines, etc.) and programs for specific industry needs (engineering, petroleum, etc.).

Registers and B-boxes include distributor, upper and lower accumulators, and three index registers.

ARITHMETIC UNIT

	Incl Stor Access Microsec		Exclud Stor Access Microsec
Add	Variable		288(Optimized)
Mult	Variable	2,210-19,600	10,000(Optimized)
Div	Variable	6,000-23,400	12,000(Optimized)

Construction (Arithmetic unit only)

Vacuum Tubes Type	Quantity
6350	208
5965	122
6211	132
5687	7
Diodes Type	
AP	499
Transistors	0
Condensers	231

Arithmetic mode	Serial by character
Timing	Synchronous
Operation	Sequential

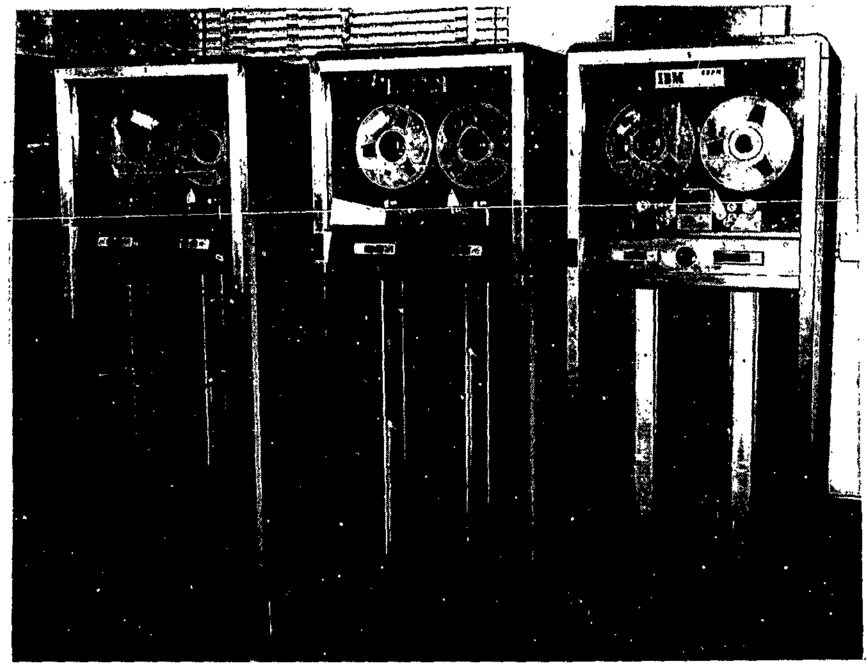


Photo by U. S. Army Engineer Supply Control Office

STORAGE

Manufacturer Media	No. of Words	Access Microsec
Magnetic Drum	2,000 or 4,000	96 min 4,800 max
Magnetic Core	60	96
Magnetic Tape	500,000 per unit	800,000 max/60 words
Magnetic Disk RAMAC (650)	600,000	

Magnetic Tape

No. of units that can be connected	6 Units
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	1.5 Inches
Tape speed	75 Inches/sec
Start time	10.8 Millisec
Stop time	10.8 Millisec
Average time for experienced operator to change reel of tape	180 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Ferrous coated acetate or mylar

Mylar is DuPont's registered trademark for its polyester film.

INPUT

Manufacturer Media	Speed
Cards	200 or 250 cards/min
Magnetic Tape	15,000 char/sec

150 cards/min may be read from read feed of Type 407 Accounting Machine when attached. A 10-word input buffer is provided which allows computation to proceed for 272 millisec of the 300 millisec necessary to reach a card. A 60-word magnetic core buffer is available between magnetic tape and the magnetic drum. Each of these words of core is addressable between the magnetic tape and the magnetic drum. Each of these words of core is addressable and can be used for rapid access storage when not reading or writing magnetic tape (96 microsec per word access). Tape from IBM 702, 704 or 705 Systems can be read by this tape unit. Rewind time for 2,400 feet of tape is 1.2 minutes. The IBM 650 (RAMAC) (355) and the IBM 650 (Tapes) utilize a 537 Read-Punch Unit operating at 155 cards/minute.

OUTPUT

Manufacturer Media	Speed
Cards	100 or 250 cards/min
Magnetic Tape	15,000 char/sec
Line Printer	150 lines/min
(wheel type)	120 char/line

A 10-word output buffer is provided which allows computation to proceed for 565 milliseconds of the 600 milliseconds necessary to punch a card. A 60-word magnetic core buffer is available between the magnetic tape and the magnetic drum. Each of these words is addressable and can be used for rapid access storage when not reading or writing magnetic tape (96 microseconds per word access). Printer connected directly to main frame of computer through a 10-word print buffer. Printer connected to magnetic tape frame, independent of computer. The IBM 650 RAMAC and IBM 650 Tape Systems utilize a 537 Read Punch Unit with a speed of 155 cards/minute.

DEMONSTRATION - Dr. James E. Scroggs, computing center supervisor at the University of Arkansas, shows Larry David of Beebe, an engineering student, how the new IBM 650 Computer works. The computing center at the University is the only one in Arkansas. (Caption furnished by U. of Arkansas)

Photo by University of Arkansas

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Manufacturer Quantity
Tubes	
6350	545
5965	269
6211	296
5726	107
5687	148
12AY7	11

Type	Quantity
Diodes	
F	3,302
AP	639
J	2
Transistors	0
Magnetic Cores	3,600

For a RAMAC 650 with 4 disk units and 6 magnetic tape units, the total system requirement is tubes 5,467; diodes 11,428; transistors 211; and magnetic cores 3,600.

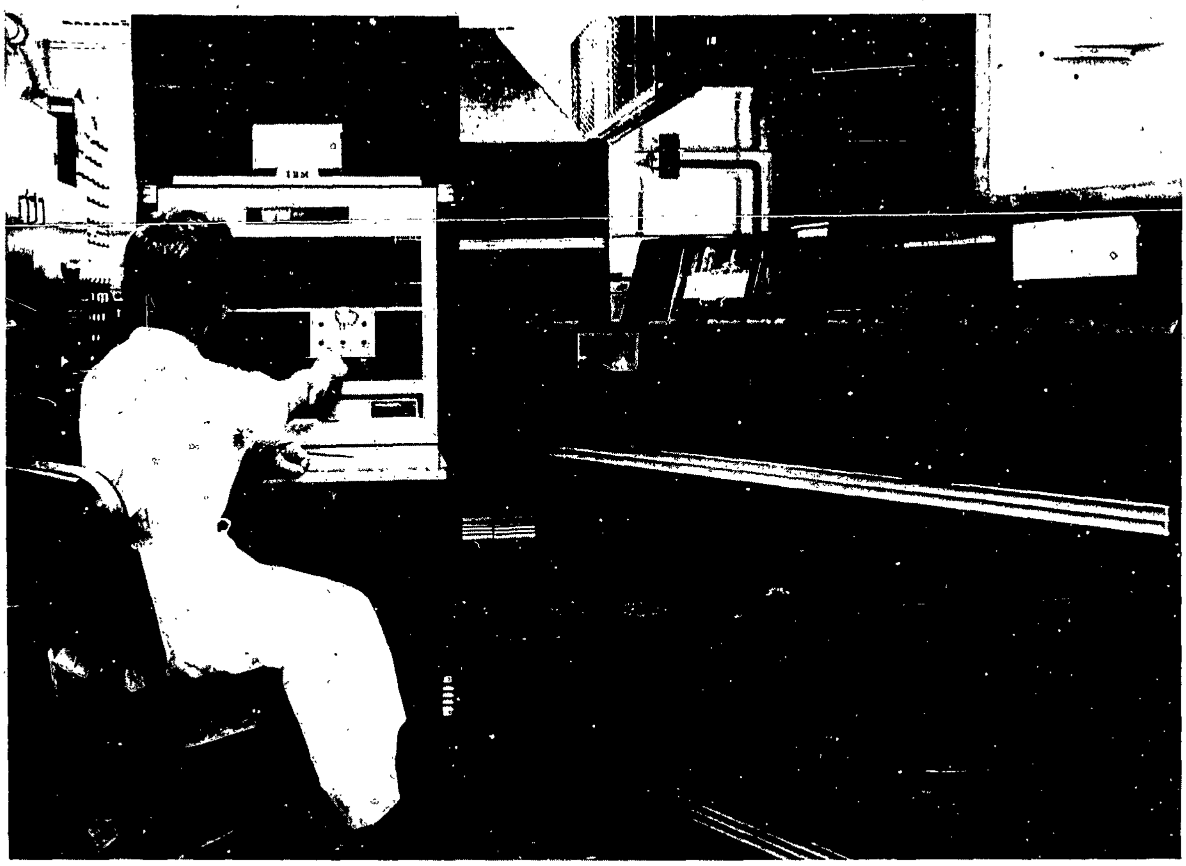


Photo by Georgia Institute of Technology RECC

CHECKING FEATURES

Manufacturer

Validity character check (data and instructions), non-existent addresses and order codes, double punch and blank column, overflow of accumulator, divide check, horizontal and vertical parity checks on magnetic tape, magnetic tape to card check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	17.7 KVA
Volume, computer	270 cu ft
Area, computer	45 sq ft
Weight, computer	5,656 lbs

USA SCO

Power, computer	77.8 KVA
Power, air conditioner	15.0 KVA
Volume, computer	15,030 cu ft
Area, computer	1,503 sq ft
Room size, computer	17 ft x 69 ft plus 15 ft x 22 ft
Floor loading	19 lbs/sq ft 200 lbs concen max
Capacity, air conditioner	25 Tons

400 ampere, 4 wire, 3 phase, 60 cycle, 208 volt power supply. Exhaust hoods and ducts on 650, 655, 652, 653, 774. Filter bank. Ductwork connecting existing two ten ton air-conditioners to computer room. Two internal partitions removed.

USA Phila QM Depot

Power, computer Tape 650	52.6 KVA
Volume, computer	1,902 cu ft
Volume, air conditioner	21,000 cu ft
Area, computer	317 sq ft
Area, air conditioner	15,000 sq ft
Room size, computer	40 ft x 80 ft
Room size, air conditioner	100 ft x 50 ft
Floor loading	54 lbs/sq ft 186 lbs concen max
Capacity, air conditioner	60 Tons chilled water
Weight, computer	17,070 lbs

Computer Room Floor	$ 7,591
Air Conditioning	46,340
Installing I Beams	1,518
Plate Glass Windows	450
Preparation	4,733
Ceiling	1,442
Lighting	3,351
Power	7,498
Cables & Fittings	1,100
Plumbing	170
Plaster	1,022
Total	$75,215

Air conditioner used to cool computer room is a 60 ton chill water unit using a 60 HP motor to drive compressor, 15 HP motor to drive condenser and several

Photo by Indiana University

3 HP units to drive water pumps. This air conditioner is located in a room with a 75 ton unit used to cool the EAM Division. The size of the air conditioning room is approx. 50 ft. x 100 ft. The floor is concrete. The computer air conditioner is designed in such a way that should it fail, the 75 ton unit will cut off from the EAM room and convert conditioning to the computer room.

USN AF

Power, computer	39.4 KVA
Volume, computer	408 cu ft
Area, computer	71.8 sq ft
Room size, computer	552 sq ft
Floor loading	24 lbs/sq ft
	900 lbs concen max
Weight, computer	13,370 lbs

Hood and blower system constructed and installed in ceiling for heat take-off.

USAF San Bernardino AMA

Power, computer	23 Kw	16.8 KVA	0.86 pf
Power, air cond	40 Kw	50 KVA	0.80 pf
Volume, computer		196.4 cu ft	
Area, computer		36.4 sq ft	
Room size, computer		300 sq ft	
Floor loading		290 lbs/sq ft	
Capacity, air conditioner		50 Tons	
Weight, computer		6,263 lbs	
Weight, air conditioner		10,500 lbs	

Site preparation included modification of approximately 1,320 sq. ft. of a permanent type warehouse. The modification consisted of installation of ceiling height partitions, voltage regulators, distribution panels, 50 TR air conditioner on roof of building and necessary duct work. Air conditioning system used jointly with Burroughs 205 Computer System.

USAF Hq SAC

Power, computer	36.1 Kw	62.7 KVA	0.85 pf
Volume, computer		9,600 cu ft	
Area, computer		1,200 sq ft	
Room size, computer		28 1/2 ft x 42 ft	
Floor loading		22.5 lbs/sq ft	
		2,972 lbs concen max	
Weight, computer		21,720 lbs	
Weight, air conditioner		1,500 lbs	

Installation of a pedestal floor. Air conditioning plenum. Extension and distribution of existing building power source. Installation of two wall panels of power circuit breakers in the computer area. Installation of a small "air handler" to augment the regular main building air conditioning system. Air conditioner is the main building system.

American Airlines

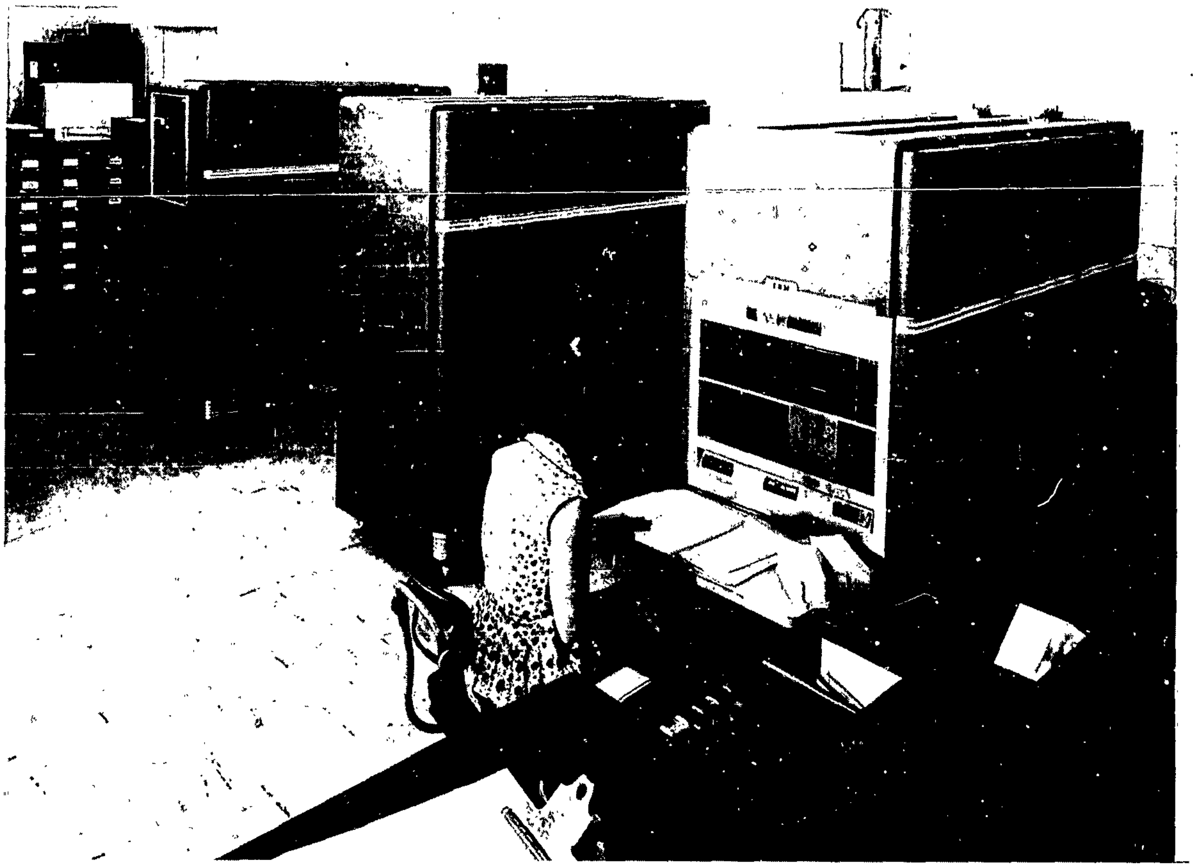
Area, computer	400 sq ft
Weight, computer	6,198 lbs

Motor driven ventilating fan with exhaust hoods.

Bridgeport Brass Co.

Power, computer	17.6 Kw	17.7 KVA
Volume, computer		194.7 cu ft
Volume, air conditioner		48 cu ft
Area, computer		36.1 sq ft
Area, air conditioner		6 sq ft
Room size, computer		500 sq ft
Floor loading		100 lbs/sq ft
		1,000 lbs concen max
Weight, computer		5,491 lbs

Power outlets provided and air conditioner installed.



--Photo by University of California LRL

Tennessee Eastman Co.

Power, computer 29.4 Kw	35.9	KVA	0.82 pf
Power, air cond 6.5 Kw	7.34	KVA	0.88 pf
Volume, computer	271	cu ft	
Volume, air conditioner	3,000	cu ft	
Area, computer	49	sq ft	
Area, air conditioner	250	sq ft	
Room size, computer	450	sq ft	
Room size, air conditioner	400	sq ft	
Floor loading	200	lbs/sq ft	
	1,000	lbs concen max	
Capacity, air conditioner	37	Tons	
Weight, computer	9,135	lbs	
Weight, air conditioner	8,500	lbs	

Installed in existing office building. Added a raised floor, separate air conditioning equipment with air supply from ceiling and from floor. Also separate power panel.

Ford Motor Co.

Volume, computer	348	cu ft
Volume, air conditioner	80	cu ft
Area, computer	53	sq ft
Area, air conditioner	10	sq ft
Room size, computer	500	sq ft
Floor loading	150	lbs/sq ft
	160	lbs concen max
Capacity, air conditioner	7 1/2	Tons
Weight, computer	8,200	lbs for the 650, 655, 533, and 407
Weight, air conditioner	600	lbs

Prefabricated steel and glass partitions to enclose 500 sq. ft. area. Power lead in. Fresh air intake to implement the closed - circuit air conditioner. Water intake and outlet for air conditioner. Air conditioner is a standard York 7.5 Ton unit.

Littauer Stat. Lab.

Power, computer 15 Kw	17.7	KVA	0.840 pf
Volume, computer	218	cu ft	
Area, computer	38	sq ft	
Room size, computer	37	ft x 17 ft	
Floor loading	165	lbs/sq ft	
	1,500	lbs concen max	
Capacity, air conditioner	5.25	Tons	
Weight, computer	6,263	lbs	
Weight, air conditioner	400	lbs	

Western Electric Co.

Power, computer 71.8 Kw	90	KVA	0.8 pf
Power, air cond 40 Kw	50	KVA	0.8 pf
Volume, computer	12,000	cu ft	
Volume, air conditioner	3,000	cu ft	
Volume, total	15,000	cu ft	
Area, computer	1,500	sq ft	
Area, air conditioner	300	sq ft	
Area, total	1,800	sq ft	
Room size, computer	30	ft x 50 ft	
Room size, air conditioner	45	ft x 20 ft	
Room size, total	36	ft x 50 ft	
Floor loading	27	lbs/sq ft	
	100	lbs/sq ft concen max	
Capacity, air condition	28 1/2	Tons	

Weight, computer 32,930 lbs
Weight, air conditioner 5,500 lbs

Raised flooring, wood and glass partitioned room, air conditioner room; constructed in a brick and steel building.

Columbia Univ.

Installed on existing reinforced-concrete floor.

Marquette Univ.

New power line distribution installed.

Stanford Univ.

Volume, computer	300 cu ft
Volume, air conditioner	1,225 cu ft
Area, computer	50 sq ft
Area, air conditioner	175 sq ft
Room size, computer	225 sq ft
Room size, air conditioner	250 sq ft
Capacity, air conditioner	40 Tons

Renovate existing 70-year-old stone building; remove partitions; poured slab floor with raceways; no structural modifications. Air conditioner is shared with a Burroughs 220 and EAM.

Univ. of Houston

Nothing special, except power supply. (System is located in a room originally designed for a small TV studio.)

Yale Univ.

Power, computer	16.8 KVA
Volume, computer	196 cu ft
Volume, air conditioner	120 cu ft
Area, computer	36 sq ft
Area, air conditioner	20 sq ft
Room size, computer	800 sq ft
Floor loading	150 lbs/sq ft
Capacity, air conditioner	20 Tons
Weight, computer	5,400 lbs
Weight, air conditioner	1,000 lbs

PRODUCTION RECORD

Manufacturer

Time required for delivery 8 months

COST, PRICE AND RENTAL RATES

	Basic	Manufacturer Rent/Month (Incl Maintenance)	Purchase	Maint. Per Month
650	Console	$2,400	$115,000	$185.00
655	Power Supply	800	42,400	34.25
533	Card Read Punch	550	25,000	52.75
	Additional Equipment			
652	Tape and/or File Control Unit (7 Models)	$ 975-$1,950	$46,800-$93,600	$46.75-$97.50
653	Core Storage Unit (11 Models) (With or w/o Index Register and Floating Point)	1,050- 2,425	57,750-133,400	28.50- 81.75
727	Magnetic Tape Units (6 maximum)	550	18,200	119.00
355	Disk Storage (4 maximum) - 2 models	975	62,200	194.00
		1,500	74,800	306.00
838	Inquiry Station (10 maximum)	175	7,500	28.00
654	Auxiliary Alphabetic Unit (4 models)	470- 950	28,700- 57,300	23.50- 54.75
537	Card Read Punch	700	40,000	53.50
407	A/C Machine (with Sync.)	1,000	51,000	132.00
543	Card Reader	325	14,650	29.25
544	Card Punch	475	20,250	31.50
655	Power Supply (2 additional models)	1,100	58,300	46.00
		1,400	74,200	58.00

USA ESCO

Basic System

The 650, 655, 543, 544, 797, 653, 652, 727 (7), 654, 774, 747, 407, and 519 rent at $16,548/month.

Additional Equipment

The 024, 026, 056, 066, 068, 082, 083, 077, 087, 407, 519, 523, 528, 548, and 602 rent at $8,000/month.

Maintenance is included in rental.

USA Richmond QM Depot

Type 650 Machine No. 800

Components special devices and total approximate cost

Type 650 Basic System	$2,400
1 table lookup on equal at $25 ea.	25
1 basic minus circuitry at $16 ea.	16
1 set format at $70 ea.	70
1 modified branch on distributor at $9 ea.	9
Type 533 Card Read Punch w/special devices	868
Type 652 Control Unit	1,350
Type 653 H. S. Storage Unit	1,975
Type 655 Power Unit w/Alph. Synchronizer	875
4 Type 355 Disk Storage at $975 ea.	3,900
5 Type 727 Tape Unit at $550 ea.	2,750

Total monthly rental for components and devices $14,238

Type 650 Machine No. 700

Components and special devices and total approximate cost

Type 650 Basic System	$2,400
1 table lookup on equals	25
1 basic minus OP code	16
1 set format	70
1 modification branch on distributor	9
Type 652 Tape Control and Power Unit	1,050
Type 653 High Speed Buffer Storage (with RAMPC circuits)	1,990
Type 655 Power Unit w/Alph. Synchronizer	875
4 Type 727 Tape Units at $550	2,200
Type 533 Card Read Punch-w/devices	868
Total monthly rental	$9,503

Additional Equipment and Total Approximate Cost

Type 774 Tape Data Selector w/file search	$2,500
Tape Data Selector Power, Type 747	500
Type 727 Tape Unit	550
Type 407 Accounting Machine w/devices	1,010
Doc. Orig. Machine	210
Total monthly rental	$4,770

USN AF

Basic System

650 Mdl. 2, 653 Mdl. C2, 727 Mdl. 1 (2), 533 Mdl. 1, 652 Mdl. al, and 655 Mdl. 1 rent at $7,925/month.

Additional Equipment

Alpha. Device, Addn. Special Characters and Alpha. Device Synch. rent at $350/month.

USN Bureau of Naval Weapons

Basic System		Monthly Rental
650	Magnetic Drum Processing Unit	$2,486
655	Power Unit	875
533	Card Read Punch	946
652	Tape Control Unit	1,050
653	Storage Unit	2,425
654	Alphabetic Unit	690
727	Magnetic Tape Unit	550
727	Magnetic Tape Unit	550
727	Magnetic Tape Unit	550
727	Magnetic Tape Unit	550
727	Magnetic Tape Unit	550
727	Magnetic Tape Unit	550
		$11,772

Additional Equipment		Monthly Rental
774	Tape Data Selector	$2,500
747	Tape Data Selector, Power Unit	500
407	Accounting Machine, Model B3	1,030
519	Document Originating Machine	234
727	Magnetic Tape Unit	550
		$4,814

USAF Hq MAAMA, Olmsted AFB

Component	Basic Rental	Add Equip Cost	Total Rental
Console, Mdl 2 w/t	$2,400	$100	$2,500
Control Unit for Tapes, Mdl Al	1,050	-	1,050
Stor Unit Mdl C3	1,975	-	1,975
Aux Alpha Unit, Mdl 4	950	13	963
Power Unit, Mdl 2	1,100	150	1,250
Tape Unit, Mdl 1	550	-	550
Tape Unit, Mdl 1	550	-	550
Tape Unit, Mdl 1	550	-	550
Tape Unit, Mdl 1	550	-	550
Tape Unit, Mdl 1	550	-	550
Card Read Punch	550	353	903
Card Read Punch	550	353	903

System No. 2 Total Basic Rental Cost $4,293

Rental rates for additional equipment

Additional Equipment	Rental Cost	
Aux. Synchronizer	$100	
Total Console Add Equip Cost		$100
12 Word Smitch	13	
Total Aux Alpha Add Equip		13
Alph Dev Synchronizer No. 1	75	
Alph Dev Synchronizer No. 2	75	
Total Power Unit Add Cost		150
Alphabetic Device	175	
6 dhl punch blk col detection	48	
2 grps Rd, Pch cards selectors	20	
2 grps 5-2 Pos Pilot selectors	20	
Half-time emmitter Rd & Pch Feed	10	
2 grp 4-5 Pos Co-selectors	10	
Special Char 11 & 12 only	25	
Aux. Alpha Modification	45	
Total Card Rd Pch Add Equip Cost		353
6 grps double pch blank col detection	48	
2 grps 5-2 Pos Pilot selectors	20	
2 grps 4-5 Pos Co-selectors	10	
Half-time emmitters, Rd & Pch Field	10	
2 grps Rd and Pch Selectors	20	
Alphabetic Device	175	
Aux. Alpha Modification	45	
Special Char 11 & 12 only	25	
Total Card Rd, Pch Add Equip Cost		353

USAF San Bernardino AMA

Type	Description	Monthly Rental Prime Shift
650	Central Processing Unit	$2,400
655	Power Unit	990
533	Input Output Unit	883
		$4,273

USAF Hq SAC

The system consists of:

650 Console Model 2
652 Control Unit Model C1
653 Storage Unit Model C3
654 Aux. Alpha Unit Model 2
655 Power Unit Model 1
727 Mag. Tape Unit Model 1
747 Tape Data Selector Power
774 Tape Data Selector

The monthly rental is $17,293.

American Airlines

The computer, card read-punch, and power unit rent at $4,000.10/month.

Bridgeport Brass Co.

Basic System	Cost	Monthly Rental
650 Model 2 Console	$150,000	$2,400
533 Read-Punch	25,000	780
655 Power Unit	42,400	875
Total	$217,400	$4,055
Additional Equipment		
652 Model A1 Control Unit	$50,400	$1,050
727 Model 1 Magnetic Tape	18,200	550

Tennessee Eastman Co.

Basic System

The 650 Console Unit, 655 Power Unit, 533 Card Read-Punch sells for $217,400 and rents at $4,600/month.

Additional Equipment

The 653 Storage Unit, immediate access storage, automatic floating point, index accumulators and mode switch, 533-655 Alpha Device, extra selectors and special features cost $154,900 and rents at $2,944 per month.

Maintenance is included in rental contract - approximately $536/month.

Ford Motor Co.

The IBM 650, 533, 407, and 655 rents at $5,800/month.

Littauer Stat. Lab

The IBM 650 rents at $1,662/month. All other machines from key punch to tabulator rent at $528/month.

RCA Service Co., BMEWS Project

Model	Description	Monthly Charge
650	Console	$2,400
655	Power Unit	800
14	Synchronizer	75
E91844	Min. works 11 & 12, 7 & 8	115
533	Read Punch Unit	550
13	Alpha Feature	175
300	DPBC Detection (6)	48
705	Co-Selectors (2)	10
729	Read and Punch Code Selectors (2)	20
323	Emitter (Read Feed)	5
776	Spec. Char. Feature	25
E91844	Input	30
407	Accounting Machine	920
54	Automatic Control (2)	10
899	Zero & Spec. Char. Control (4)	40
514	Reproducing Punch	125
328	Punch Emitter	3
201	Class Selectors (2)	8
551	M/S Punch Feed	50
807	Collator	245
RPQ88506		75
83	Sorter	110

26	Alpha Sorting	15
65	Card Counter	7
774	Sort Suppression	2
557	Alpha Interpreter	165
628	Proof Device	30
606	Print Entry Control	5
325	Emitter	3
780	Spec. Char. Printing	10
		$6,096

Western Electric Co.

The 650 (1) - $2,400; 655 (1) - $1,250; 533 (1) $833; and 407 (1) - $1,240 are rented.

The 653 (1) - $1,975; 355 (1) - $975; 774 (1) - $2,400; 519 (1) - $258; 407 (1) - $1,023; 727 (6) - $3,300; 652 (1) - $1,350; 747 (1) - $500; and 727 (1) - $550; are rented.

Columbia Univ.

The 650, 533, 655, Floating Point, Indexing, Alphabetic, and Special Character rent at $67,200/year, total.

The 407, 026, 026, 080, 077, 519 rent at a total of $14,500/year.

Marquette Univ.

The IBM 650, 533, 2 keypunches, reproducer, and printer rent at $1,850/month.

Stanford Univ.

The 650, 655, and 533 rent at $2,400 + 875 + 780 per month less 60% educational contribution.

The 402 rents at $430 per month, less 60% educational contribution.

Maintenance is included in rental.

Univ. of Houston

IBM 650 with alphabetic and special characters, 026 collator, 407 reproducer.

Yale Univ.

4 keypunches (026), 1 reproducer (519), 1 tabulator (407), 1 collator (087), 1 interpreter (557), 1 sorter (082), and 1 statistical sorter cost $39,000 (including 60% discount).

The 650 drum unit, power unit, read punch unit rents at $4,000/month (less 60% educational discount).

$938/month less discount for special character device, additional selectors, half time read emitter, digit set punch feed, additional double punch detection units.

Maintenance included in rental.

PERSONNEL REQUIREMENTS

Manufacturer

Complete programming and advanced programming training available as well as individual installation assistance.

USA ESCO

	1st 8-Hour Shift	2nd 8-Hour Shift	3rd 8-Hour Shift
Supr & Adm	16	2	1
Analysts	5		
Programmers	32		
Clerks & Sec.	13	3	2
Librarians	1		
Operators	21	19	10
Engineers	IBM		
In-Output Oper	2	2	2

Operation tends toward open shop.

Methods of training includes IBM schools and on-the-job training.

USN AF

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts	7	7
Programmers	2	2
Operators	1	1

Operation tends toward closed shop.

Methods of training used includes manufacturer's training classes, on-the-job training, and special "on station" classes for symbolic coding.

USAF San Bernardino AMA

SBAMA EDP personnel requirements support the logistical mission. Additional personnel support the PCAM effort. PCAM is utilized in an integrated data processing system to provide extra off-line capability. Coders are included in the programmer category.

Because of the varying quantitative effect and diverse character of the workload in the AMC logistical support, an inflexible recommendation of personnel was not attempted. Cross-trained personnel qualified to employ techniques in various computer configurations provide system flexibility.

Engineers and technicians to service and maintain the EDP equipment are provided on a contractual basis by the manufacturer concerned.

Extra shift time for analysts, programmers and clerks is not on a regularly scheduled basis. Whenever the workload demands, personnel hours are specially scheduled.

System analysis, development and programming staff operate on one 8-hour daily shift, 5 days per week. Computer operations staff work on three 8-hour daily shifts, 7 days weekly. Supervision is included under Burroughs 220 Computer System operations staff.

Operation tends toward closed shop.

Methods of training used includes formal training by manufacturer and on-the-job training.

USAF Hq SAC

	Three 8-Hour Shifts Used	Recommended
Supervisors	2	2
Analysts, Programmers & Coders	11	10
Clerks	-	1
Librarians	-	2
Operators	5	10
Engineers	2	3

Operation tends toward closed shop.

Methods of training used includes manufacturer's instruction classes, on-the-job training, and internally conducted instruction classes.

U. S. Dept. of Interior

	One 8-Hour Shift
Supervisors	1
Analysts	5
Operators	1
Engineers	IBM

Operation tends toward combination open and closed shop. Some engineers in design branches write their own programs with assistance from the Engineering Applications Section of the Automatic Data Processing Branch. The Engineering Applications Section also prepares programs and makes production calculations on a closed shop basis for many design and project offices.

Design engineers of some years experience in the Denver office are detailed to the Engineering Applications Section for 90 days to learn computer capabilities, problem formulation, and programming and coding techniques. Younger engineers spend 90 days in the Section on Rotation Schedules. Filed personnel are detailed to the Section to learn requirements for the preparation of field data as well as basic computer techniques.

American Airlines

	One 8-Hour Shift
Programmers	1
Operators	1

Operation tends toward open shop.

Methods of training used are on-the-job training supplemented by classroom, and instruction provided by the vendor.

Bridgeport Brass Co.

	One 8-Hour Shift	
	Used	Recommended
Supervisors	2	2
Analysts	3	3
Programmers	2	2
Clerks	2	2
Operators	1	1

Operation tends toward open shop.

Methods of training used includes on-the-job, equipment manufacturer's schools, and college courses.

Tennessee Eastman Co.

One combined EAM and computer operations supervisor, one machine methods supervisor, one applied mathematics supervisor. It is hoped that translators will be developed to the state that coders will not be required. The clerk controls data and schedules use. Three operators trained so we can operate 24 hours per day if necessary. Service is supplied by manufacturer. We operate and pay rental based on 176 hours per month as one shift rather than the standard 8 hours per day shift.

We do not feel that the present size of our staff is ideal for us or anyone else. It would not be practical to obtain as large a staff as would be needed to study all problems simultaneously.

	One 8-Hour Shift
Supervisors	3
Analysts	4
Programmers	4
Coders	2
Clerks	1
Operators	3

Operation tends toward closed shop.

Methods of training used includes manufacturer training courses and on-the-job training.

Littauer Stat. Lab

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	2	2
Analysts	3	5
Programmers	10	8
Clerks	2	2
Librarians	1	1
Operators	2	2
In-Output Oper	1	-

Operation tends toward open shop.

Methods of training used includes on-the-job training along with some introductory SOAP and FORTRAN classes at IBM.

Western Electric Co.

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Programmers	4	4
Clerks	1	1
Librarians	1	1
In-Output Oper	2	2

Methods of training used include IBM 650 class, systems analysis, industrial engineering, and work simplification.

Columbia Univ.

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	1	
Programmers	5	6
Operators	1	

Operation tends toward open shop.

Methods of training used includes IBM sponsored classes and practical experience.

Marquette Univ.

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	1	1

Operation tends toward open shop.

Univ. of Houston

	One 8-Hour Shift
Supervisors	1
Analysts	1.5
Programmers	1
Clerks	2
Operators	1

Operation tends toward open shop.

Yale Univ.

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	-
Analysts	-	1
Programmers	3	2
Coders	-	3
Clerks (student aides)	3	3
Librarians	0	1
Operators	0	1
Engineers	Supplied by IBM	

Methods of training used includes classroom instruction by manufacturer, classroom instruction by staff of University, and occasional individual instruction.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USA ESCO

Average error-free running period 40 Hours
Good time 440.7 Hours/Mo. (Average)
Attempted to run time 454.3 Hours/Mo. (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period from Oct 59 to May 60
Passed Customer Acceptance Test Jul 57
Time is not available for rent to outside organizations.

USN AF

Good time 33.5 Hours/Week (Average)
Attempted to run time 34.3 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.977
Above figures based on period 1 Feb 60 to 31 Mar 60
Passed Customer Acceptance Test 1 Jan 58
Time is available to other government agencies and their contractors.

USN Portsmouth Naval Shipyard

Good time 77 Hours/Week (Average)
Attempted to run time 81 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period 1 Apr 60 to 30 Jun 60
Passed Customer Acceptance Test Apr 56
Time is not available for rent to outside organizations.

Average running period in which no machine failures are experienced is 38 hours. There has been no experience where the computer has produced erroneous data that has not been detected through machine check points. Scheduled preventive maintenance by the manufacturer's customer engineer amounts to 6 hours

weekly. The attempted to run time indicated above does not include test and debug time.

USAF SB AMA
Passed Customer Acceptance Test 1 Apr 60
Time is not available for rent to outside organizations.

USAF Hq AFSWC, Kirtland AFB
Good time 36 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.90
Above figures based on period 1 Jan 60 to 1 May 60
Passed Customer Acceptance Test 1 Dec 55
Time is not available for rent to outside organizations.

USAF Hq SAC
Average error-free running period 100 Hours
Good time 134 Hours/Week (Average)
Attempted to run time 138 Hours/Week (Average)
Operating ratio 0.97
Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 23 Dec 58
Time is not available for rent to outside organizations.
Equipment is regularly scheduled 24 hours per day, 7 days per week.

U. S. Dept. of Interior
Average error-free running period 81.0 Hours
Good time 37.4 Hours/Week (Average)
Attempted to run time 38.7 Hours/Week (Average)
Operating ratio 0.968
Above figures based on period 1 Jan 60 to 30 Jun 60
Passed Customer Acceptance Test 8 Dec 59
Time is available for rent to qualified outside organizations.
Scheduled preventive maintenance: 3 hours per week
Unscheduled down time:
1.25 hrs/week for period 1 Jan 60 thru 30 Jun 60
.35 hrs/week fpr period 1 Mar 60 thru 30 Jun 60

American Airlines
Good time 33 Hours/Week (Average)
Operating ratio 0.989
Above figures based on period from Jan 59 to Mar 60
Passed Customer Acceptance Test Jan 59
Time is not available for rent to outside organizations.

Bridgeport Brass Co.
Good time 35 Hours/Week (Average)
Attempted to run time 35 Hours/Week (Average)
Operating ratio 1.0
Above figures based on period 1 Jan 59 to 1 Jan 60
Passed Customer Acceptance Test Oct 58
Time is available for rent to outside organizations.

Tennessee Eastman Co.
Average error-free running period 104 Hours
Good time 49.5 Hours/Week (Average)
Attempted to run time 50 Hours/Week (Average)
Above figures based on period from Aug 58 to Mar 60
Passed Customer Acceptance Test Jun 58
Time is available for rent to qualified outside organizations. Operating ratio - 0.99
With six exceptions, all machine failures have been in the 533 card read and punch unit. The computer has made only one error which it failed to detect.

Ford Motor Co.
Average error-free running period Two Weeks
Good time 40 Hours/Week (Average)
Attempted to run time 41 Hours/Week (Average)
Operating ratio 0.975
Above figures based on period 1 May 60 to 31 May 60
Passed Customer Acceptance Test 1 Aug 59
Time is not available for rent to outside organizations.

Littauer Stat. Lab.
Average error-free running period One Month
Good time 40 Hours/Week (Average)
Attempted to run time 40.5 Hours/Week (Average)
Operating ratio 0.99
Above figures based on period 1 Feb 60 to 29 Feb 60
Passed Customer Acceptance Test 1957
Time is not available for rent to outside organizations.

Western Electric Co.
Good time 37 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.925
Above figures based on period 16 May 60 to 17 Aug 60
Passed Customer Acceptance Test Aug 59
Time is not available for rent to outside organizations.

Columbia Univ.
Average error-free running period Intermittent - as long as a week
Good time 60 Hours/Week (Average)
Attempted to run time 75 Hours/Week (Average)
Operating ratio 0.80
Above figures based on recent period
Passed Customer Acceptance Test Jul 58
Time is not available for rent to outside organizations.

Marquette Univ.
Good time 39 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.98
Passed Customer Acceptance Test Aug 58
Time is available for rent to qualified outside organizations.

Stanford Univ.
Time is not available for rent to outside organizations.
Usage of this system is erratic, since it is largely by students whose demands tend to peak at ends of quarters.

Univ. of Houston
Good time 48 Hours/Week (Average)
Attempted to run time 56 Hours/Week (Average)
Operating ratio 0.857
Above figures based on period from 56 to 60
Time is available for rent to outside organizations.

Yale Univ.
Good time 95 Hours/Week (Average)
Attempted to run time 100 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period from Jul 57 to Aug 60
Time is available for rent to educational institutions only.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
Outstanding reliability and performance. Large amount of customer experience and interchange of programming approaches and techniques.

USA ED, Omaha
Outstanding features are the machine is extremely reliable, card drive is well suited for solution of engineering problems, easy to program, debug and operate, and is well suited for scientific computations.

Several new machines have been announced which appear to offer equal speed and reliability with the IBM 650 at a lower cost. These machines are being analyzed in an effort to provide this office with the best machinery, compatible with our workload, at the lowest possible cost.

USA ER & DL

Outstanding features include self checking features of IBM 650 makes results more reliable and card system facilities program debugging and development changes.

USA EWES

Outstanding features include internal validity checking of all data and instructions, ease of programming, and availability of large program library.

Unique system advantages include input/output by punched cards allows maximum flexibility in data and programming.

USA CE USAED, North Pacific

Outstanding features are system is very dependable and relatively easy to program.

USA ESCO

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include the use of press-on labels. The reels are placed in plastic containers. The plastic containers are kept in metal files. Shipping is in plastic cases within 35 mm film metal containers within boxes. Tapes are stored in the air conditioned computer room.

USA Ord Frankford Arsenal

Outstanding features include random access ability to do a great deal of in-line processing while updating inventory records on a daily basis and ability to provide substitute items in one pass by use of chaining all substitutes in Ramac with the preferred items.

Unique system advantages include ease of file maintenance by utilizing the federal S/N only once throughout the 4 Ramac units. The key to additional trailer records is the 5 digit Ramac address. No tape sorting is used by utilizing Ramac to the utmost advantage.

Contents of Ramac is dumped on magnetic tape weekly and stored in another location in the arsenal. Inventory and other records are exchanged at an alternate site on a monthly basis.

USA Ord Feltman Res. & Eng. Labs.

Outstanding features are alphabetic - special character device (useful in symbolic and automatic programming), automatic floating decimal arithmetic and index registers.

USA Ord Anniston Ord Depot

Unique system advantage is random access to stored data.

The procedures established by the manufacturer for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage are followed by this depot.

USA Richmond QM Depot

The labelling of magnetic tapes is a permanent reel number and they are filed in numerical sequence. The tape librarian collaborates with supervisors and establishes a temporary title for the tape. A file of cards is maintained by reel number and they are arranged in numerical sequence within tapes in use, tapes in reserve, permanent tapes and available tapes. The tapes in use are also filed in numerical sequence within the date they will again be available. This enables the librarian to take a daily inventory of tapes available, and tapes to be available. The librarian checks all returned tapes for damage or report of faulty operation.

The tapes are stored in metal filing cabinets and the room which contains them satisfies the temperature and humidity control set up by the tape manufacturers.

No smoking is allowed while handling the tapes as a fire precaution.

For a 650 System with magnetic tape and/or disk storage, a suitable area for use by the customer engineers, maintaining the installation, should be provided by the customer. Minimum 50 sq. ft. 10 ft x 5 ft. A Pass and Seymour No. 7250 receptacle (or equivalent) should be installed for powering the tape drive tester.

USN Air Dev. Cen.

Outstanding features include Ramac, tapes, alphabetic, floating point, index registers, and scientific applications.

USN Avionics Facility

For the storage of magnetic tape, the humidity is regulated between 20% and 80%. The temperature is held between 70° and 80°F. Tapes are protected by dust covers.

USN Bureau of Naval Weapons

Reels and cans are labeled by job number. Tape library is in separate air conditioned room and consists of tape racks and shelves.

USN Portsmouth Naval Shipyard

Consider the accuracy of the computer as outstanding and no serious delay due to downtime has been experienced during a period exceeding four years.

USAF Mobile AMA

Outstanding feature is range of hardware from small to large scale permits automatic data processing of workloads of varying scope, complexity, and sophistication.

Unique system advantage: Standardization of equipment configurations within the Air Materiel Command, USAF, provides for processing of centrally designed and programmed systems, command wide.

Tape procedures: Tape storage is accomplished in secure storage vault with the same temperature and humidity controls required for the ADPE. Personnel traffic control is emphasized in machine processing and tape storage areas. Each tape reel is permanently labelled with a tape serial number when it enters the tape inventory. In addition to a label on the magnetic tape itself, each reel is labelled to identify information on magnetic tape. Perpetual inventory and tape history, including incidence of error conditions, is maintained for each reel of magnetic tape. Fire hazards and electrical interference are strictly controlled in the machine processing and tape storage area. Standard cardboard tape shipping containers have been used with minor incidence of breakage to plastic reel containers, and negligible tape or tape reel damage or distortion of data.

USAF APGC (PGCS), Eglin AFB

Unique system advantages are accuracy, moderate cost, sub-routine availability, central air conditioning system. System has two additional alpha words.

USAF Hq Europe

Outstanding features are equipment very reliable and high level of production is maintained.

Tapes have both physical external label and internal tape header and trailer records. Programs automatically check internal labels. Tapes stored in fire proofed air conditioned vault and shipped in manufacturers' containers.

EDPS is used on varied applications ranging from business type record keeping to psuedo-scientific computations. EDPS functions as part of headquarters data processing center equipped with conventional punched card equipment (PCAM), auditing staffs & etc.

USAF Hq MATS, Scott AFB

Tapes are identified with a label which indicates program which generated the tape, as of date, tape number, and number of tapes in the series. All tapes are stored in a fireproof vault. The humidity and temperature are controlled by the central air conditioner.

USAF Hq SAC

The outstanding feature is the random access, large capacity storage.

Entire tape library is located within the computer room. Shipping tapes is generally by mail - packaged in original plastic envelope and carton. Tapes are labelled by machine recording and affixing a standard format adhesive label th the exterior of the reel.

USAF 2709th AF Vehicle Control Gp.

An outstanding feature is the alphabetic device. Unique system advantages include speed, reliability, efficient storage, ability to re-code, and word size emitter.

Tape storage is under a water sprinkling system and enclosed in an air conditioned room.

U. S. Dept. of Interior

System used is basic IBM 650 with alphabetic device, half-time emitter on read feed, additional pilot selectors, co-selectors, read and punch code selectors, and double punch and blank column detection. Additional equipment was added to permit use of SOAP, SIR, and FORTRANSIT.

US Treasury Dept., Internal Revenue Service

Outstanding features (as compared to previous equipment (IBM Type 604s)) include stored programs, one computer instead of a battery of computers, and variable, rather than fixed, speed.

Unique system advantages include a wider range of applications is now feasible and experience has been gained in the use of stored-program equipment.

Bell Telephone Labs., Inc.

An outstanding feature is accuracy and speed.

Bridgeport Brass Co.

Duplicate program decks and procedures stored in separate, distant area.

Chase Manhattan Bank

Outstanding feature is that the system is completely self-checking.

A unique system advantage is the availability of tape driven tabulator known as tape data selector.

Air conditioning and humidity controls are employed. Records required for reconstruction of magnetic tape data stored at Records Center at Granite Springs, New York.

Combustion Engineering, Inc.

Outstanding feature include three index accumulations; six tape units, and floating decimal operation.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage are monitored by tape librarian, who is responsible for maintaining, storing, and shipping tapes. The Computer Center was designed with the above described hazards in mind.

Educational Testing Service

An outstanding feature is the reliability of system-minimum of down time with limited amount of scheduled preventive maintenance time.

Emerson Electric Mfg. Co.

Paper inserted into slots on the reel and gummed tape are used for visual identification of magnetic tape reels. Magnetic labels are inserted in tape files at the beginning of a reel for computer program identification of the reel.

Cleveland Engine Plants, FOMOCO

An outstanding feature is that computer includes alphabetic devices.

Lincoln-Mercury Div., FOMOCO

A unique system advantage is more and better data at less processing cost.

Tractor & Implement Div., FOMOCO

Tapes are stored in fire-resistant safe located in computer room, which is temperature and humidity controlled.

Adv. Prod. Study & Engrg. Res. Office, FOMOCO

Equipment used with this system also includes a punched-card to curve point plotter (Benson-Lehner) and a B-L Model "K" OSCAR, Oscillogram-to-Punched Card Data Transcription Device.

In addition to the IBM 650 Digital Computer, this activity also operates a 120-amplifier analog computer installation, using equipment manufactured by Electronic Associates and Goodyear Aircraft Corporation. This equipment is used primarily for solution of problems in vibration, vehicle stability and servo system design.

A. C. Spark Plug Div., General Motors Corp.

Outstanding features include automatic floating decimal device, index registers, and core storage.

Tape records are kept on IBM cards and a report submitted weekly on tapes stored. Tapes are stored in air conditioned room in metal cabinets. No need to ship tapes.

Littauer Stat. Lab.

Outstanding features are low rates for university research, immediate machine scheduling, and small staff and personalized service.

Metropolitan Life Ins. Co.

A unique system advantage is the in-line method of processing reduces processing time.

Olin Mathieson Chemical Corp.

Outstanding features are better than 90% utilization, 100% use of storage on most work gives strong competitive position, no control board changes; all programs written by computer center; they use one board, index accumulators, and floating decimal point hardware, enabling more rapid programming and computing of scientific problems.

Republic Aviation Corp.

Outstanding features are read punch, floating point arithmetic, index registers, and auxiliary core storage.

Socony Mobil Oil Co., Inc., New York

Outstanding features are floating point arithmetic and 700 series compatibility.

All tapes are stored in computer room. No special precautions taken in relation to protection from humidity, temperature and physical, electrical, fire, or other damage.

Standard Oil Co. of California

A unique system advantage is its self-checking capability.

New York Stock Exchange

A unique system advantage is reduction of card handling to a minimum.

United Gas Corp.

An outstanding feature is accuracy through validity check points.

Western Electric Co.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage, include tape librarian, system for purging tapes, open files in library room, and temperature and humidity control.

Western Electric Co., Allentown Works
Outstanding features are dual card read feeds (through IBM 533 and IBM 407 Units) and elimination of the need to collate master and detail card decks.

Western Electric Co., Indianapolis
An outstanding feature is index registers, which allow address modifications thereby reducing program size and programming effort. Random access plus building block feature to provide for flexibility for required memory capacity.

Labelling - tape reels are externally labeled; in addition a tape mark is written containing the purge date.

Storage - Current tapes are stored in the computer room in wright-line tape cabinets.

Protection - Previous generation tapes are placed in plastic bags and stored in a vault located in another area of the plant.

Western Electric Co., Omaha
Machine is equipped with following features:
Alphabetic Device
Special Character Device Group I
20 Pilot Selectors
16 Co-Selectors
Digit Emitter on Read and Punch
Half Time Selectors on Read and Punch

Western Electric Co., Winston-Salem
Outstanding feature is the on-line IBM 407 Printer.

Georgia Institute of Tech., Rich ECC
Outstanding feature is the large library of subroutines and simplified programming systems (i.e. B.G.P.S., Fortran).

Indiana Univ.
A unique system advantage is ease of programming was important in the open shop operation.

Iowa State Univ.
This 650 is used on an open shop basis, 24 hours a day if and when desired by the users. The users consist of all departments on the campus who have computing needs. The 650 is located in the Statistical Laboratory which in turn consults, teaches and uses the 650 in the normal course of its daily activities.

Johns Hopkins Univ.
An outstanding feature is the alphabetic attachment.

Louisiana State Univ.
Outstanding features are index registers and automatic floating point device.

Oklahoma State Univ.
Outstanding features are special characters groups 1 and 2, floating point, index registers, and core storage.

Univ. of Mississippi
The system is a commercially available one, with no modifications made or proposed.

Univ. of Southern Cal., Aeronautic Lab. Dept.
A unique system advantage is the ability to reduce test data on-line without disadvantages of direct connection of computer to instrumentation.

Univ. of Wisconsin
General-purpose system suited to very wide variety of problems.
Tapes are kept in machine room. No special procedures or precautions.

Virginia Polytechnic Institute
The wide-spread use of this system provides excellent opportunities for interchange of programs.

See "ILLIAC" file for 650 information.

FUTURE PLANS

USA ED, Omaha
Projected Equipment Procurements
Retain the installed IBM 650 Card-operated Electronic Computer in its present form through FY 1961.

Provide a second shift computer operation when computer utilization exceeds a continuous 100%.

Provide a tape drive, floating decimal and index accumulators when the capacity of the present machine is exceeded. This should become necessary during FY 1962 or 1963.

Continue to evaluate new equipment in order to provide the best and most modern equipment consistent with cost and district requirements.

Projected Plans for Increasing Computer Utilization
Provide top level direction of the computer operation.

Encourage all district organizations to utilize the computer facilities and to provide technical assistance where needed.

Teach all scientific and engineering personnel to perform computer programming.

Provide a computer staff with engineering and scientific technical ability.

Continue the training of computer specialist in order to provide an adequate staff.

USA Eng. Res. & Dev. Lab.
A digital plotter has been added. This is a high resolution point and line plotter for up to 30 x 30 inches, symbols, or continuous photo.

USAE. Waterways Exp. Sta.
Consideration is being given to the addition of automatic floating point arithmetic and index registers as extra features to the present machine in order to provide capability sufficient to meet present and foreseeable needs.

USA CE, USA ED, North Pacific
Our complex reservoir system planning and operational analyses requirements indicate a larger system is necessary for comprehensive analyses wherein optimization of reservoir regulation on a system basis can be accomplished. Currently the restrictions on memory capacity and computing speed limit the amount of work which can be accomplished in this connection. This need, together with our increasing computer work load on other engineering studies and possible extension of the work into the comptroller field, has led to the investigation of possibilities of extending the present system and of utilizing a larger scale computer system. It appears feasible in the future to extend our present 650 system to include a 653 Immediate Access Storage which includes 60 additional words of high speed memory, floating point (decimal locating) accumulators, and indexing registers or replace the 650 system with one of approximate or greater capabilities of the expanded system at possibly lesser cost. This would give us an effective increase of speed and memory which would assist in meeting our foreseeable immediate requirements. An IBM 407 Accounting Machine, which is on an average 50 cards per minute faster then the installed 402, would facilitate listing, tabulating and summarizing data. There is some evidence that a system other than the 650 system with on line printing capabilities may better serve the requirements of this Division.

USA ESCO

Proposed systems changes are currently deferred pending decision on Single Manager for Construction assignment within the Corps of Engineers which will, in some areas require larger computer systems in accordance with the volume received. However, data processing systems as produced, are constantly being investigated and evaluated. Currently, a study of the IBM 1401 Data Processing System is being performed.

USA Ord Frankford Arsenal

It is planned to replace 3 Model 1 Ramac Units by 2 Model 2 (Double Density Units). This will provide a needed additional 10,000 of random access storage for an additional $75.00 per month.

A request is in process to replace our present tape data selector and all its components by an IBM 1401. This replacement will provide much more speed in printing reports and will enable us to use the 1401 for small projects requiring computation. It will be used for specific tape jobs now being accomplished on the 650. This replacement is practically the same rental but will provide a much more flexible ADP operation.

USA Ord Feltman Res. & Eng. Labs.

Installation of a large-scale digital computing system is under consideration. Present large-scale problems are run by local personnel and contractors on machines available off the Arsenal. Present applications are increasing rapidly and new applications of major proportions are anticipated. Target date for installation of an IBM 709 on a rental basis is tentatively set for January 1961. An IBM 1401 will be used for auxiliary off-line operations. The IBM 650, which is now used for the major part of two shifts on problems which can be accommodated within its speed and storage capacity, will be returned to the manufacturer upon installation of the large-scale system.

USA Ord Watervliet Arsenal

As soon as studies can be completed the following additional applications will be placed on the computer:

Supply inventories, personnel statistics, nationwide gage inventory, planning and estimating, material control, appropriation accounting, general accounting, tooling inventory, machine loading and scheduling, and preventive maintenance program.

USA Ord Anniston Ord Depot

It is anticipated that an IBM 1401 Data Processing System will be acquired to replace the present tape data selector system.

At present there are studies being made of some 13 areas of data processing for possible mechanization.

USA Richmond QM Depot

Future plans are now being taken into consideration by a planning group composed of programmers and analysts. Future plans call for the integration of the IBM 7070. This will be augmented by the 1401. This will most likely modify our present system by replacing the one 650 system (with disk storage). Work volume under the new single manager will eventually determine our proposed systems.

USA Signal Corps School

Installation of militarized computer to be used for educational purposes.

Expansion of computer laboratory and facilities (proposal).

USN Service Center

Analysis is now in progress to replace the IBM 650 with either an IBM 1401 or RCA 301 Card System. Both systems have the capacity for expansion and installation of either would result in an overall savings to Navy. Those savings would be both tangible and intangible.

USN Air Development Center

Research and development program on ACL Digital Data Center which gives added capability to data handling capabilities.

USN Bureau of Naval Weapons

This system is due to be removed soon, to be replaced with a later model system.

USN New York Naval Shipyard

This activity has recently recommended the acquisition of an intermediate size tape computer. Proposed applications, i.e., payroll, supply, cost, scheduling, are more readily adaptable to tape systems as against EAM card systems. The computer considered to meet this shipyard requirement is the National Cash Register NCR 304 Machine.

USN Portsmouth Naval Shipyard

A study is under way regarding replacement of the IBM Type 533 Card Read Punch Unit by an IBM Type 543 Card Reader and an IBM Type 544 Card Punch to increase computer availability time through these faster input-output units. Indications at this time point to such action.

Plans are under way to develop an integrated data processing system for the shipyard and when finally developed, and if approved, will require a larger scale computer system.

USN Puget Sound Naval Shipyard

Design of integrated system (procedures) currently being performed in connection with proposed installation of an IBM 7070 Data Processing (magnetic tape) System.

USN Supply Center, Oakland

NSC, Oakland is presently analyzing and programming for Philco 2000 Computer. This equipment is slated for delivery. The equipment on order includes the following components:

Quantity	
1	Model 210 Arithmetic & Control Unit, Console and Typewriter, including 8 index registers.
1	Model 2204 Magnetic Core Storage Unit (4096 words)
11	Model 234 Magnetic Tape Units, 2 units, on line/off line
1	Model 235 Input-Output Processor (16X1)
1	Model 256 Printer System (900 lpm), on line/off line
1	Model 258 Punched Card Reader (2000 lpm), on line/off line
1	Model 259 Punched Card Control Unit
1	Model 260 Card Punch (100 lpm), on line/off line
2	Model 280 Universal Buffer Control Units

Initial applications for the 2000 will be inventory control for 670,000 stock items, both quantitatively and financially; requisition status for all inputs; civilian payrolls; labor distribution; and employees savings bond accounting.

USAF Hq MAAMA, Olmsted AFB

Implementation of a mechanized payroll system providing for preparation of civilian payroll checks, bond issuance program, and leave and earning statement is scheduled for December 1960.

USAF Mobile AMA

Applications: Expansion, integration, and sophistication of current systems will saturate computer capabilities for the immediate future.

Equipment: Transistorized equipment is on order (IBM Type 1401) to replace currently installed auxiliary equipment for card to tape, tape to card, printing, and data selection functions. The use of this equipment for edit and sort operations, simple

main frame runs, and possible PCAM applications is being explored. Long range plans include the acquisition of large scale, solid state data processing equipment.

USAF San Bernardino AMA

Future developments involving EDPE in AMC activities are generated at Hq AMC, Wright-Patterson AF Base, Dayton, Ohio.

USAF Hq AFSWC, Kirtland AFB

A change of systems is anticipated during FY 62. Determination of system to be utilized has not been made at this time.

USAF APGC (PGCS), Eglin AFB

543 Card Reader and 544 Card Punch scheduled to replace 533.

USAF Hq, Europe

An increase in utilization is anticipated due to an expansion of a present data analysis application. Future plans indicate a requirement for larger capacity equipment within two years.

USAF Hq MATS

Because of the increasing demands of the MATS staff for more and varied statistical information necessary for proper management, this installation is planning on a transition to a "second generation" computer during 1961. The application in which the greatest expansion is expected to occur is the field of operation and traffic.

USAF Hq, Pacific

Request has been made for a larger capacity computer to permit advancement in electronic data processing.

USAF Hq PACAF

Requirements for a system with greater capacity and speed to meet demands for weather applications and other classified programs will be undertaken shortly with a projected installation date of 1 July 1961.

USAF ROAMA, Griffiss AFB

One 650 being retired.

USAF Hq SAC

The 650 Tape RAMAC System will be replaced by an NCR 304 EDP System. The primary application will remain in the personnel accounting and authorizations area. The processing will be extensively altered, however, to include "machine decisions" on most manning actions and personnel transfers throughout the command.

USAF 2709th AF Vehicle Control Gp.

Retirement of stock control and distribution (inventory management) application is contingent upon implementation on Type 705 EDPE.

New application is to be monetary property management.

California Division of Highways

We are continually developing new applications, however, overall usage has leveled off.

New equipment will be obtained when faster compilation and additional storage are available at approximately the same price.

U. S. Dept. of Interior

Additional applications will be put on computer in future as need develops and after it is known they are proper problems for the equipment.

U. S. Treasury Dept., Internal Revenue Service

Future plans fall into two categories:

Short range: Internal Revenue will convert present processes to an IBM 7070 System at Lawrence, Mass., Kansas City, Mo., and Ogden, Utah. Each 7070 System will perform the work now done by a 650 and the sizeable battery of EAM equipment which supports it. Each 7070 System will use magnetic tape as the principal medium of computer input and output. IBM 1400 series equipment will be employed for card-to-tape conversion and printing and, in addition, each system will include Type 408 Printers. Operations on these systems will begin 1 January 1961 at Lawrence and 1 January 1962 at Kansas City and Ogden.

Long range: Internal Revenue is developing plans for an automatic data processing system which will be centered around a master file of U.S. taxpayers' accounts and which will incorporate the bulk of the present returns processing and other clerical and accounting processes. The planned installations are a computer center which will maintain the master file, and peripheral service centers which will send data to, and receive data from, the computer center. The system is scheduled to begin operationa tests 1 January 1962 in the computer center and one service center. Present schedules call for phased extension of the system over the period from then until 1969.

American Airlines

Proposed replacement by IBM 7070.

Crosley Div., Avco Corp.

We plan to increase our digital computing capacity during the last half of 1961. The equipment being considered are the IBM 7070 with 1401, and the Honeywell 800 with the 400. No definite decision will be made on these machines until all studies are complete. Present tentative plans call for using the equipment for such commercial applications as: production scheduling, inventory control, and personnel time allocation, as well as for all the scientific computations.

Bell Telephone Labs., Inc.

Planning for either an additional IBM 650 Machine or an IBM 1401 Machine.

Bendix Aviation Corp., Res. Labs. Div.

Will replace present systems with following system in the Fall of 1961.

Bendix G20 Computer, 8K Core Memory, line printer, card input-output, and auxiliary card handling equipment.

Braniff Airways, Inc.

Now making study of tape system to replace present computer. New applications being considered are flight crew scheduling and utilization, and flight equipment maintenance scheduling.

Bridgeport Brass Co.

Possible acquisition of more powerful computer for new or expanded applications.

The Chase Manhattan Bank

An RCA 501 is to be installed for demand deposit accounting. A Univac Solid State 80 is to be installed for corporate trust accounting. An IBM 1401 is to be installed for payroll and employee benefits work.

Combustion Engineering, Inc.

We anticipate receiving a IBM 7070 to replace the 650 unit. Also, we will lease an IBM 1401. No alteration in the computer site will be necessary.

With the addition of the above described units present program and systems will be converted. These units will permit us to install an effective long range scheduling system to cover the major portion of our manufacturing business. Also, a system is being developed which will indicate the state of our contracts.

More comprehensive programs will be developed for equipment design, stress and thermal analysis problems.

Convair-Pomona, General Dynamics

We will install new card input/output equipment.

The 533 will be replaced with an IBM 543 and IBM 544. This will increase input speed 25% and output speed 150%.

Convair-Fort Worth

High speed input-output 543 and 544 on order.

Tennessee Eastman Co.

By assigning a project team to each of our three manufacturing areas we hope to coordinate all work in each area toward a master plan using the total systems approach.

A separate section, Applied Mathematics, was recently established to serve as consultants and to apply scientific techniques to equipment and process design problems, management problems, and analysis of experimental data. This group will also do research on computer and mathematical methods.

We are in the process of evaluating our future computer needs. The addition of immediate access storage, index accumulators and automatic floating point will increase speed and capacity to the point we can grow for one year.

Educational Testing Service

Plan to install an RCA 501 Computer System to replace our IBM 650 Computer System. The RCA 501 will include:

Model 503 Computer
561-2 Hi-Speed Storage
581 Tape Stations (6)
533 On-line Printer
528 Card Reader
538 Card Punch
547-6 Tape Switching Unit

El Paso Natural Gas Co.

An IBM 7070 Tape Oriented System and two 1401 Tape Systems will be delivered.

Emerson Electric Mfg. Co.

Studies are being made for the procurement of a more powerful computer to replace our present equipment.

Firestone Tire & Rubber Co.

The computer system was retired as of 30 April 1960 due to lack of work load.

Tractor & Implement Div., FOMOCO

New applications include production control (computation of parts requirements, production progress reporting, direct labor performance reporting, and stock status and inventory control) and sales analysis (order status reporting and sales statistics by product by customer).

Ford Motor Company

Intended acquisition of IBM 1401 Data Processing System.

Adv. Prod. Study & Engrg. Res. Office, FOMOCO

General intention to replace complete 650 installation with large-storage, high speed computer as work requirements develop.

Steel Div., FOMOCO

Future plans include continued programming in areas of production control, applied research, and accounting. Larger systems are being examined, probably tape, for replacement of the present card system.

General Electric Co.

Expect to eliminate the IBM 650 Tape Computer System and consolidate all tape applications on an IBM 7090 Computer located in another department. Will retain 650 Drum Type System and acquire an IBM 1401 Data Processing System.

A.C. Spark Plug Div., General Motors Corp.

Both 650 Tape Systems to be replaced by IBM 7070.

A.C. Spark Plug Div., GMC

Presently considering installation of IBM Type 7070 Tape System. Also two Type 1401 Systems. These will modify existing EAM area and replace 650 System now in use.

Harrison Radiator Div., GMC

Future plans call for retirement of present system and the acquisition of a solid state magnetic tape system.

Institute for Defense Analyses

The 650 System will be replaced by a Control Data Corporation 1604 Computer. A brief summary of the 1604 characteristics are stored program, general purpose; digital computer; 48-bit word length; six index registers; magnetic core storage, 32,768 48-bit words; 4.8 microseconds effective cycle time; 6.4 microseconds total cycle time; indirect addressing; and single address logic, 2 instructions per word.

Kaman Aircraft Corp.

In the process of doing a feasibility study for a transistorized tape-oriented system.

Martin Co.

Plan to discontinue 650's and install an IBM 7070 and 1401 Systems.

Metropolitan Life Ins. Co.

The work will probably be absorbed eventually by a large-scale system; of a type that has not yet been determined.

Mutual Benefit Life Ins. Co.

It is intended to install an IBM 7070 System which will eventually replace the two card 650's.

Newport News Ship & Dry Dock Co.

We are evaluating an IBM 1401 System.

Ohio Oil Company

One IBM 7070 and 2 IBM 1401 Systems are to be installed.

Olin Mathieson Chemical Corp.

Current computer programs are exceeding storage capacity to the point where we are negotiating for a 4,000 word drum. It is recognized that this is a stop gap measure since the magnetic drum is fast becoming obsolete. We will evaluate the newer computing facilities with the intention of replacing the present IBM 650 with a more up to date computer.

Prudential Ins. Co. of America

Future plans are being constantly evolved and include: consideration of new computers; advantages of consolidating data processing in a central location; data and document transmission systems; information retrieval in connection with file and data storage problems; addition of functions to our major data processing systems (case work, random file reference, and increased processing frequency); and the use of IBM 1401 Data Processing Systems.

RCA Service Company, BMEWS Project

Expect to switch to Univac 1105.

Shell Development Co.

Release of this equipment is planned.

Socony Mobil Oil Co., Inc.

The IBM 650 will be replaced by an IBM 7090 and an IBM 1401.

Standard Oil Co. of California

System will be retired, with programs converted to IBM 7090 or 1401.

United Gas Corp.

Future plans are to install a magnetic tape oriented system. The configuration of equipment consists of the following:

Qty	Item	Machine Number	Monthly Rental
1	Console Control Unit	7150	$ 300
1	Core Storage	7301-2	7,025
1	Arith. Unit w/Float. Point	7601	4,350
1	Core Storage Control	7602-2	2,000
1	Magnetic Tape Control	7604-1	2,700
10	Magnetic Tape Units	720-4	9,000
1	Console Card Reader	7501	75
2	Processing Units Model C-3	1401	6,910
2	Card Read Punch Model 1	1402	1,100
2	Printers Model 2	1403	1,550
			$35,010

This order for equipment was placed 27 January 1960 with the understanding that it may be cancelled or changed by us at any time, with no obligation on our part, to conform to our future data processing equipment requirements and with the understanding that the IBM organization will work with us on conversion and that delivery schedule of the equipment will be arranged to coincide with our requirements.

Upon delivery and installation of this equipment, we will expect to release a substantial part of the equipment now in use in our Shreveport, Louisiana and Houston, Texas offices.

Universal Oil Products Co.

Entire system will be replaced in 1961 by a purchased IBM 7070 System with card input-output, 5,000-word core storage, floating point instructions.

Western Electric Co., New York

Constant study for new developments and improvement of present applications. Also study of new machine systems for potential ability to improve systems, capacity and cost. For example, we are studying substitution of 1401 and/or 7070 System for 650 Tape System. Present indications are that 1401 System will give more favorable capacity to cost relationship and improve present systems.

Western Electric Co., Allentown Works

Anticipated modifications include installation of new card read and punch units to obtain faster card speeds. IBM 543 and 544 units will replace IBM 533 unit. Acquisition of new systems - planning on starting feasibility study to replace existing system with newer equipment.

Western Electric Co., Indianapolis

An additional IBM 650 Tape-Ramac System, to be employed for mechanization of shop scheduling and process inventory control, is on order, consisting of:

1 Type 650 Console
1 Type 655 Power Unit
1 Type 652 Control Unit
1 Type 653 I. A. S. Unit
2 Type 727 Tape Units
1 Type 355 Disk Storage
1 Type 407 On-line Printer
1 Type 543 Read Unit
1 Type 544 Punch Unit

The existing Type 533 Read Punch Unit is to be replaced by a Type 543 Read Unit and Type 544 Punch Unit.

Western Electric Co., Omaha

Proposed complete system on production control in the manufacture of telephone switching equipment, including explosion of assemblies into component parts, scheduling of production facilities taking into consideration economical quantities and reorder points, feed back to maintain control and associated accounting and managerial reports. Scientific inventory control and the latest techniques on control of production will be used to produce a completed integrated system.

We are currently conducting a feasibility study to determine what size and type of a latter generation of machine will be required. Present indications point to a core storage machine with tapes in the medium size area. Probable on the air date: Early 1962.

Auburn Univ.

An order has been submitted for one 077 series 50 collator and one 548 interpreter.

Brigham Young Univ.

We now plan to purchase IBM 650 with 4,000 word drum. No other changes currently anticipated for near future.

Colorado State Univ.

Plan to get an IBM 650 the Summer 1960.

Columbia Univ., Elect. Res. Labs.

Proposal for an expanded system includes addition to present system of: floating point capability; index registers (3 units); rapid access storage (60 words total); tape units (2 units).

Facility improvement by providing a self-contained air conditioner for the computing equipment to enable stable temperature and humidity control.

Cornell Univ.

Since the program in which this system is a part is still growing, it will be necessary to obtain larger and faster equipment in the not too distant future. In all probability a system with magnetic tape facilities will be obtained.

Florida State Univ.

Acquisition of a 700 or 7000 series computer is planned for October 1961. New computing center is currently under construction and negotiations for a larger computer are in progress.

Indiana Univ.

It is anticipated that sometime soon after 1 July 1961 the Center will replace the 650 Tape System with an IBM 7070 System. The approximate configuration will be:

	7150	Console (Model 1)
	7600	Input-output Control (Model 1)
	7601	Arithmetic & Program Control (Model 1)
	7602	Core Storage Control (Model A2)
	7603	Input-output Synchronizer (Model 4)
	7301	Core Storage 10K (Model 2)
	7604	Tape Control (Model 1)
	7400	Printer (Model 1)
	7550	Card Punch (Model 1)
2	7500	Card Readers (Model 1)
7	729	Magnetic Tape Units (Model 4)

Iowa State Univ.

Will add a 4,000 word drum.

Johns Hopkins Univ.

IBM 7090 Computer System with 1401 C3 planned for installation.

Marquette Univ.

Adding floating decimal, indexing registers, and special characters group.

Montana State College

To be acquired are a 653 unit and a 407 unit.

North Carolina State College

Plan to replace 650 System with Rem. Rand Univac Solid State 80 with 4 tape units.

Syracuse Univ.

Expanded system to be installed.

Texas Engineering Experiment Station

The 704 will be replaced with a 32K - 2 channel - 8 tape IBM 709.

Univ. of Arkansas

Needless to say, we hope to add to our basic 650 installation. It is hoped that at the end of about a year of operation that we can add index registers, 60 words of core storage, and floating point arithmetic.

Univ. of Georgia

Plan to add 600 position core storage, 3 indexing registers, and floating decimal arithmetic device.

Univ. of Kentucky

Plan to obtain 101 Statistical Sorter in near future.

Univ. of Rochester

A larger high-speed system is needed. Several solid state systems, such as IBM 7070, are under consideration for installation within the next 12 - 18 months. This will replace present system.

Univ. of Southern California

Expect to replace 650 with IBM 1620 when card I/O becomes available.

Univ. of Wisconsin
CDC 1604 and 160 Computers planned to replace 650. No major changes planned in peripheral equipment. Staff increases of around 100% planned during next two-year period.

Washington State Univ.
Washington State University plans to replace the present 650 with an IBM 704 System including 4K core storage, 8K magnetic drum and 4 magnetic tape drives in July 1961.

Yale University
A new computing center with an IBM 7070 and IBM 1401 System by 1 July 1961, with 10,000 words of core storage, floating point arithmetic, and 10 magnetic tapes, two of which are shared by the 1401.

INSTALLATIONS

U. S. Army Engineer District, Omaha, 1709 Jackson Street, Omaha, Nebraska

U. S. Army Engineer Research and Development Laboratories, Data Processing and Statistical Services, Fort Belvoir, Virginia

U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

U. S. Army Corps of Engineers, U. S. Army Engineer Division, North Pacific, 210 Custom House, Portland 9, Oregon

U. S. Army Engineer Supply Control Office, Corps of Engineers, 410 North Broadway, St. Louis 66, Missouri

U. S. Army Ordnance Frankford Arsenal, Field Service Group, Philadelphia, Pennsylvania

U. S. Army Ordnance Feltman Research and Engineering Laboratories, Picatinny Arsenal, Dover, New Jersey

U. S. Army Ordnance Watervliet Arsenal, ADPS Branch, Watervliet, New York

U. S. Army Anniston Ordnance Depot, Machine Accounting Services Division, Anniston, Alabama

U. S. Army Philadelphia Quartermaster Depot, Military Clothing and Textile Supply Agency, 2800 South 20th Street, Philadelphia 45, Pennsylvania

U. S. Army Richmond Quartermaster Depot, Richmond, Virginia

U. S. Army Signal Corps School, Automatic Data Processing Section, Fort Monmouth, New Jersey

U. S. Navy Service Center, Washington 25, D. C.

U. S Naval Air Development Center, Johnsville, Pennsylvania

U. S. Naval Avionics Facility, Indianapolis, Indiana

U. S. Navy Department, Bureau of Naval Weapons, 18th & Constitution Ave., N. W., Washington 25, D.C.

New York Naval Shipyard, Brooklyn 1, New York

Portsmouth Naval Shipyard, Comptroller Department, Portsmouth, New Hampshire

Puget Sound Naval Shipyard, Bremerton, Washington

U. S. Naval Supply Center, Oakland, Oakland 14, California

U. S. Air Force, Headquarters OCAMA, Tinker Air Force Base, Oklahoma

U. S. Air Force, Headquarters MAAMA, Comptroller, Olmsted Air Force Base, Pennsylvania

U. S. Air Force, Mobile Air Materiel Area, Office of Comptroller, Brookley Air Force Base, Alabama

U. S. Air Force, San Bernardino Air Materiel Area, Norton Air Force Base, California

U. S. Air Force, AFSWC, Statistical Services Division, Kirtland Air Force Base, New Mexico

U. S. Air Force, APGC (PGCS), Directorate of Statistical Services, Eglin Air Force Base, Florida

U. S. Air Force, Headquarters Europe, Directorate of Statistical Services, APO 633, New York, N. Y.

U. S. Air Force, Headquarters, Military Air Transport Service, Scott Air Force Base, Illinois

U. S. Air Force, Headquarters Pacific, Statistical Services, APO 953, San Francisco, California

U. S. Air Force, Headquarters Pacific, A-3 Directorate of Control, APO 953, San Francisco, California

U. S. Air Force, ROAMA, Griffiss Air Force Base, New York

U. S. Air Force, Headquarters Strategic Air Command, Statistical Services Division, Offutt Air Force Base, Nebraska

U. S. Air Force, 2709th AF Vehicle Control Group, 3300 Jackson Avenue, Memphis 2, Tennessee

N.A.S.A. Flight Research Center, box 273, Edwards, California

U. S. Department of Agriculture, Commodity Stabilization Service, Evanston, Illinois

California Division of Highways, 1120 "N" Street, Sacramento, California

U. S. Department of Commerce, Coast and Geodetic Survey, Washington 25, D. C.

U. S. Department of Interior, Bureau of Reclamation, Denver Federal Center, Denver, Colorado

U. S. Treasury Department, Internal Revenue Service, Collection Division, 10th & Constitution Avenues, Washington, D. C.

American Airlines, 100 Park Avenue, New York, New York

Advanced Technology Laboratory, American Standard, Mountain View, California

Crosley Division of Avco Corporation, 1329 Arlington Street, Cincinnati 29, Ohio

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio

Bell Telephone Laboratories, Incorporated, 3300 Lexington Road, S.E., Winston-Salem, North Carolina

Bell Telephone Laboratories, Incorporated, Allentown Laboratory, 555 Union Boulevard, Allentown, Pennsylvania

Bell Telephone Laboratories, Incorporated, 463 West Street, New York 14, New York

Bell Telephone Laboratories, Incorporated, Murray Hill, New Jersey

Bendix Aviation Corporation, Research Laboratories Division, P. O. Box 5115, Detroit 35, Michigan

Braniff Airways, Incorporated, Exchange Park, Dallas, Texas

Bridgeport Brass Company, 30 Grand Street, Bridgeport 2, Connecticut

The Chase Manhattan Bank, 57 William Street, Room 200, New York, N. Y.

The Chesapeake & Potomac Telephone Company of Maryland, 5711 York Road, Baltimore 12, Maryland

Clark Brothers Company, Division of Dresser Operations, Incorporated, Olean, New York

Combustion Engineering, Incorporated, 200 Madison Avenue, New York 16, New York

Convair, Division of General Dynamics, Pomona, California

Convair, Division of General Dynamics, Fort Worth, Texas

Douglas Aircraft Company, Department B7-250, El Segundo, California

Dow Chemical Company, Texas Division, B-2402, Plant B, Freeport, Texas

Tennessee Eastman Company, Division of Eastman Kodak Company, Kingsport, Tennessee

Educational Testing Service, 20 Nassau Street, Princeton, New Jersey

El Paso Natural Gas Company, Administrative Services Department, P. O. Box 1492, El Paso, Texas

The Emerson Electric Manufacturing Company, 1567 Salzman Avenue, Wellston, Missouri
The Firestone Tire & Rubber Company, Guided Missile Division, 2525 Firestone Boulevard, Los Angeles 54, California
Cleveland Engine Plants, Cleveland Computer Center, FOMOCO, P. O. Box 191, Berea, Ohio
Ford Motor Company, Lincoln-Mercury Division, 3000 Schaefer Road, Dearborn, Michigan
Ford Motor Company, Tractor & Implement Division, 2500 E. Maple Road, Birmingham, Michigan
Ford Motor Company, Dearborn Stamping Plant, Controller's Office, Box 494, Dearborn, Michigan
Ford Motor Company, Advanced Product Study & Engineering Research Office, 20000 Rotunda Drive, Dearborn, Michigan
Ford Motor Company, Steel Division, 3001 Miller Road, Dearborn, Michigan
General Electric Company, Large Jet Engine Department, Building 800, Evendale 15, Ohio
A. C. Spark Plug Division, General Motors Corporation, 7929 S. Howell Avenue, Milwaukee 1, Wisconsin
A. C. Spark Plug Division, General Motors Corporation, 1300 N. Dort Highway, Flint, Michigan
Harrison Radiator Division, General Motors Corporation, Lockport, New York
Institute for Defense Analyses, Weapons Systems Evaluation Division, Room 1E871, The Pentagon, Washington 25, D. C.
The Kaman Aircraft Corporation, Old Windsor Road, Bloomfield, Connecticut
Littauer Statistical Laboratory, 94 Prescott Street, Cambridge 38, Massachusetts
The Martin Company, Baltimore 3, Maryland
Metropolitan Life Insurance Company, 1 Madison Avenue, New York 10, N. Y.
Michigan Bell Telephone Company, 23500 Northwestern Highway, Southfield, Michigan
Mutual Benefit Life Insurance Company, 520 Broad Street, Newark 1, New Jersey
Newport News Ship & Dry Dock Company, Tabulating Department, Washington Avenue, Newport News, Virginia
The Ohio Oil Company, 539 South Main Street, Findlay, Ohio
Olin Mathieson Chemical Corporation, Liquid-Fuels Computer Center, 275 Winchester Avenue, New Haven, Connecticut
The Prudential Insurance Company of America, Electronics Research Division, Prudential Plaza, Newark, New Jersey
RCA Laboratories, Princeton, New Jersey
RCA Service Company, BMEWS Project, Griffiss Air Force Base, Rome, New York
Republic Aviation Corporation, Farmingdale, New York
Shell Development Company, E and P Research, Computing Section, 3737 Bellaire Boulevard, Houston, Texas
Socony Mobil Oil Company, Incorporated, 150 East 42nd Street, New York 17, N. Y.
Standard Oil Company of California, Western Operations, Incorporated, 225 Bush Street, San Francisco, California
New York Stock Exchange, Stock Clearing Corporation, 18 Broad Street, New York 5, N. Y.
Sun Oil Company, Marcus Hook Refinery, Marcus Hook, Pennsylvania
United Gas Corporation, 1525 Fairfield Avenue, Shreveport, Louisiana
Following sub-divisions of United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania also operate IBM 650 Computers:
- American Bridge
- American Steel and Wire
- Columbia-Geneva
- Consolidated Western
- Oliver Iron Mining
- New York Data Processing Center
- Pittsburgh Data Processing Center
- Central Operations
- U. S. Steel Supply

Universal Oil Products Company, 30 Algonquin Road, Des Plaines, Illinois
Western Electric Company, 77 South Wacker Drive, Chicago, Illinois
Western Electric Company, Allentown Works, 555 Union Boulevard, Allentown, Pennsylvania
Western Electric Company, Data Processing & Methods Development Department, 2525 Shadeland Avenue, Indianapolis, Indiana
Western Electric Company, Omaha Works, Box 1400, Peony Park Station, Omaha, Nebraska
Western Electric Company, 3300 Lexington Road, S.E., Winston-Salem, North Carolina
Auburn University, Computer Laboratory, Auburn, Alabama
Brigham Young University, Computer Center, Provo, Utah
Watson Scientific Computing Laboratory, 612 W. 16th Street, New York 27, N. Y.
Colorado State University, Computing Center, Fort Collins, Colorado
Columbia University, Electronics Research Laboratories, 632 West 125th Street, New York 27, N. Y.
Columbia University, Hudson Laboratories, Dobbs Ferry, New York
Columbia University, Nevis Cyclotron Laboratory, Box 137, Irvington on Hudson, New York
Cornell University, Dairy Records Processing Laboratory, Ithaca, New York
Florida State University, Computing Center, Tallahassee, Florida
Georgia Institute of Technology, Rich Electronic Computer Center, Atlanta, Georgia
Indiana University, Research Computing Center, Bloomington, Indiana
Iowa State University, Statistical Laboratory, Ames, Iowa
Johns Hopkins University, Applied Physics Laboratory, Johns Hopkins Road, Scaggsville, Howard County, Maryland
Louisiana State University, Computer Research Center, Baton Rouge, Louisiana
Marquette University, Computing Center, 1515 W. Wisconsin Avenue, Milwaukee, Wisconsin
Miami University, Computing Center, Laws Hall, Oxford, Ohio
Montana State College, Computer Laboratory, Bozeman, Montana
New York University, Computation and Statistical Laboratory, Research Building 3, 233 Fordham Landing Road, New York 68, New York
North Carolina State College, Experimental Statistics Department, Patterson Hall, Raleigh, North Carolina

Oklahoma State University, Computing Center, Stillwater, Oklahoma

Polytechnic Institute of Brooklyn, 333 Jay Street, Brooklyn 1, N. Y.

Rensselaer Polytechnic Institute, Computer Laboratory, Troy, New York

Stanford University, Computation Center, Stanford, California

Syracuse University, Computing Center, 112 Hinds Hall, Syracuse 10, New York

Texas Engineering Experiment Station, Data Processing Center Building, College Station, Texas

Tulane University, Computer Center, New Orleans 15, Louisiana

University of Arizona, Numerical Analysis Laboratory, Tucson 25, Arizona

University of Arkansas, Fayetteville, Arkansas

University of California, Radiation Laboratory, Box 808, Livermore, California

University of Florida, Statistical Laboratory P. O. Box 3568, University Station, Gainesville, Florida

University of Georgia, Department of Experimental Statistics, Lumpkin House, Athens, Georgia

University of Houston, Computing and Data Processing Center, Houston 4, Texas

University of Kentucky, Computing Center, Lexington, Kentucky

University of Mississippi, Computer Center, Carrier Hall, University, Mississippi

University of Rochester, Computing Center, Rochester, New York

University of Southern California, Aerodynamic Test Laboratory, Building 75, U. S. Naval Missile Center, Point Mugu, California

University of Wisconsin, Numerical Analysis Laboratory, Sterling Hall, Madison 6, Wisconsin

Vanderbilt University, Computer Center, Wesley Hall, Nashville, Tennessee

Virginia Polytechnic Institute, Temporary Building 365, Blacksburg, Virginia

Washington State University, Computing Center, Pullman, Washington

Wayne State University, Computing Center, 4841 Cass Avenue, Detroit 2, Michigan

Yale University, Computing Center, 135 Prospect Street, New Haven, Connecticut

IBM 701

IBM 701 Data Processing System

MANUFACTURER

International Business Machines Corporation

Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

Scientific, commercial, and engineering data processing.

U. S. Naval Ordnance Test Station, China Lake

Scientific data processing

Douglas Aircraft Company, Tulsa

Located at the Douglas Aircraft Company, Inc., 2000 North Memorial Drive, Tulsa, Oklahoma, and at A-250, Santa Monica, California, the systems are used for strength analysis, trajectories, aerodynamic stability, aerodynamic performance, dynamic response, thermo dynamic analysis, weight control, and propulsion analysis.

United Aircraft Corporation

The United Aircraft Corporation provides a central computing facility located at the Research Department for the solution of engineering and research problems. It services the three UAC Divisions: Pratt and Whitney Aircraft, Sikorsky Aircraft, and Hamilton Standard which are engaged in the design and manufacture of aircraft engines, helicopters, propellers and other aircraft equipment.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	18 or 36 per data word
Binary digits/instruction	18
Instructions per word	2
Instructions decoded	33
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-(2^{35} - 1) \leq N \leq (2^{35} - 1)$

Instruction word format

±	Operation		Operand	
0	1	5	6	17

Symbolic routines and floating point interpretive codes are available.

There are 3 arithmetic registers, accumulator, multiplier-quotient, and memory register.

Photo by General Motors Corporation

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	60 or 36	48 or 24
Mult	456	444
Div	456	444

Construction (Arithmetic unit only)

Vacuum tubes	4,000
Diodes	12,800
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4,096	40,960	12
Magnetic Drum	8,192 or 16,384		50,000
Magnetic Tape	Up to 900,000 words		10,000 serially

No. of units that can be connected	10 Units
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Char/sec
Start time	10 Millisec
Stop time	10 Millisec

Average time for experienced operator to change reel of tape	30 - 60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	200 - 2,400 Feet
Composition	Acetate or mylar

Mylar is DuPont's registered trademark for its polyester film.

Douglas Santa Monica and Douglas Tulsa

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4,096	36	12
Magnetic Drum	8,192	36	1,280
Magnetic Tape	6 reels		

INPUT

Manufacturer

Media	Speed
Card Reader	150 cards/min
Magnetic Tape (IBM 726)	6,000 char/sec

This speed corresponds to 10,000 digits/sec.

Magnetic Tape (IBM 727)	15,000 char/sec

This speed corresponds to 25,000 digits/sec.

Cards to Magnetic Tape	250 cards/min

Douglas Santa Monica and Douglas Tulsa

Cards	150 cards/min
Magnetic Tape	100 char/in, 75 in/sec

Photo by University of California Radiation Laboratory

OUTPUT

Manufacturer

Media	Speed
Card Punch	100 cards/min
Line Printer	150 lines/min
Cathode Ray Tube Display	8,300 points/sec
Magnetic Tape 726	6,000 char/sec
Magnetic Tape to Card	100 cards/min
Magnetic Tape to Line Printer	150 lines/min
Douglas Santa Monica and Douglas Tulsa	
Printer	150 lines/min
Cards	100 cards/min
Magnetic Tape	100 char/in, 75 in/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	
Tubes	4,000	
Diodes	12,800	
Magnetic Cores	147,456	(Core Storage)

CHECKING FEATURES

Tapes (727) - Longitudinal & transverse parity check
Line Printer - Echo checking for each character
Card Reader - Reads card twice
Card Punch - Checks columns for double punch & blank column
Arithmetic & Logical Unit - Overflow, divide check, parity checks.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	84.0 KVA
Area, computer	1,200 to 3,000 sq ft
Room size	1,600 - 3,400 sq ft
Capacity, air condit	20 - 40 Tons
Weight, computer	20,516 lbs

Physical planning manual made available.

	Weight (lbs)	KVA
Main Frame	2,850	34.4
Punched Card Recorder	720	0.7
Line Printer (Wheel Type)	2,795	3.1
Magnetic Drum	1,480	9.9
Cathode Ray Tube	2,445	11.8
Power Frame No. 1	2,810	5.8

Power Frame No. 2	2,750	5.8
Power Distribution Unit	1,230	1.2
Magnetic Tape Unit (726)	1,270	4.6
Magnetic Tape Control Unit	1,636	6.0
Punched Card Reader	530	0.7

U. S. Naval Ordnance Test Station, China Lake
System requires 80 Kw, 136 KVA, 1,404 cu ft, 1,400 sq ft. The system area is 44 by 27 ft and weighs 40,050 lbs, including peripheral equipment.
The above power, space and weight does not include supporting machines such as key punches, reproducers, and sorters. This equipment would add 8 KVA and 8,000 lbs.

Douglas Santa Monica and Douglas Tulsa

Power, computer	65.3 Kw	87.6 KVA
Volume, computer		729.4 cu ft
Area, computer		143.6 sq ft
Room size, computer		1,368 sq ft
Room size, air condi		1,100 sq ft
Floor loading		16 lbs/sq ft
		200 lbs concen max
Capacity, air conditioner		38 Tons
Weight, computer		21,690 lbs

Built-up air handling system - two units, 40 hp each, capable of approximately 38 tons cooling.
Sealed area; a/c ducts installed with 500 RCE/sink for each component; raised floor (steel platform); a/c unit and airfilter installed; motor-generator set with transformer and controls installed.

PRODUCTION RECORD

Manufacturer
Number produced to date Over 18
There are no 701 systems in production at the present time. Available for new orders only when released from present user.

COST, PRICE AND RENTAL RATES

Manufacturer

	Monthly Charge	Base Purchase Price
701 Central Processing Unit	$5,000	$230,000
711 Card Reader	400	16,350
716 Printer	1,200	54,200
721 Card Punch	600	25,000
726 Magnetic Tape Unit	850	42,100
727 Magnetic Tape Unit	550	18,200
731 Magnetic Drum Storage	1,400	87,450
736 Power Supply	1,000	57,400
737 Magnetic Core Storage	3,700	192,400
740 CRT Recorder	2,450	96,000
741 Power Supply	1,000	57,400
746 Power Distribution Unit	1,100	52,000
753 Tape Control	2,350	80,000
780 CRT Display	400	16,000

Since this machine is no longer in production, the Base Purchase Price is used in computing the Discounted Purchase Price based on the age of the installed machine. A published discount schedule is available from IBM.
Maintenance contract details available.
U. S. Naval Ordnance Test Station, China Lake
Rental rate for basic system is $21,500/month.
Rental rate for additional equipment $8,550/month.
Douglas Tulsa
Standard 701 components $17,220/month.
Third 726 Tape Unit (two reels) $850/month.
Maintenance/service is included in rental.
Douglas Santa Monica
Main frame, 6 magnetic tape units, 1 reader, 1 punch, and 1 printer $17,220/month.
Maintenance/service is included in rental.

PERSONNEL REQUIREMENTS

Manufacturer
Education training, program testing, technical assistance on all phases is available from manufacturer.
U. S. Naval Ordnance Test Station, China Lake
For three 8-hour shifts 6 engineers and 19 technician-operators are utilized. Approximately 9 mathematics aides, 10 mathematicians and 20 to 25 persons from outside the branch, program and run their own problems.
Douglas Tulsa

	One 8-Hour Shift
Supervisors	1
Analysts	6
Clerks	1
Operators	1

Operation tends toward closed shop.
Own course stresses understanding of existing programs and new programming under close supervision.
Douglas Santa Monica

	One 8-Hour Shift
Supervisors	1
Analysts	2
Clerks	1
Operators	2

Operation tends toward closed shop.
Own course followed by on-the-job training.
United Aircraft Company
Two IBM Type 704 and one IBM Type 701 Computers are operated on a 24 hour, six-day week. Three CPC's and three Burroughs E101's are operated on an 8 hour, five-day week.
The Laboratory is staffed by 51 analysts, 11 operators, and 24 aides. Non-computing personnel also program for all calculators.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Atomic Energy Commission, University of California Radiation Laboratory
System accepted 26 Apr 54; the average error-free running period is 6.2 hours; good time is 3,032 hours and the attempted to run time is 3,587 hours, resulting in an operating ratio of 0.85; the average error free running time is calculated by dividing the total hours less the total scheduled maintenance less total unscheduled maintenance less the loss time claimed by operator all by the total number of hours of down and lost time reported. The above figures are for the period January 55 to June 55 when operating 24 hours/day.
General Motors Corporation
System accepted in Apr 54; average error free running period is 4.5 hours derived from the records for 1 month; good time of 1,067 hours and attempted to run time of 1,154 hours yielding an operating ratio of 0.92 for a four month period.
Douglas Tulsa

Average error free running period	8 Hours
Good time	39.16 Hours/Week (Average)
Attempted to run time	39.96 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.98

Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 8 Mar 60
Time is available for rent to outside organizations.

Douglas Santa Monica

Average error free running period	8 Hours
Good time	40 Hours/Week (Average)
Attempted to run time	42 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.95

Above figures based on period from Jan 59 to Jul 60
Passed Customer Acceptance Test Apr 56
Time is available for rent to outside organizations.

Lockheed Aircraft Corporation

Systems accepted on 14 May 53 and 15 Jul 54; average error free running periods of 3-4 hours on one and 1 1/2 hours on the other; good time of 74.4% and 80% where good time is considered as actual production and the remaining 25.6% and 20% respectively, consists of preventive maintenance, breakdown, machine re-work and idle time. The average error free running period is reduced considerably when tapes are used frequently. Short runs are made wherever possible (1-5 hours), but the same program is run for as long as 12 hours and would run longer if time permitted.

United Aircraft Corporation, Research Dept.

Average error free running period	2 Hours
Good time	2,667 Hours
Attempted to run time	3,473 Hours
Operating ratio (Good/Attempted to run time)	0.77

Figures based on period 1 Feb 56 to 30 Sep 56
Passed Customer Acceptance Test 5 Oct 53

Attempted to run time includes calculation, checkout, machine error, unscheduled maintenance, and scheduled maintenance time. The scheduled maintenance for the above period was 367.96 hours and the unscheduled maintenance was 290.75. These two figures should be subtracted from the above "Attempted to run" figure.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include high arithmetic speed and low cost. Unique system advantages are two instructions stored per word and 18 and 36 bit data words.

Tape Storage

Acetate Base Tape

Storage for frequent usage. Relative humidity 40 to 60%. Temperature 65 to 80°F.

Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, the following item specifications would apply:

Storage for infrequent usage. Temperature 40 to 120°F.

The tape must be placed in a dust proof container and hermetically sealed in a plastic bag. Before re-using, the tape must be reconditioned by allowing it to remain in the conditioned atmosphere for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours.

Mylar Base Tape

Storage for frequent or infrequent usage. Relative humidity 0 to 80%. Temperature 40 to 120°F.

The tape should be stored in a dust proof container. Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, it must be reconditioned by allowing it to remain at the given condition for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours.

The upper limit on humidity is given to prevent the formation of fungus and mold growth. This limit may be exceeded by hermetically sealing the tape in a plastic bag.

General Precautions

The tape should not come in contact with magnetic material at any time and should never be subjected to strong magnetic fields. Either of these can cause the loss of information or the introduction of noise.

When shipping magnetic tape, the reel should be placed in a dust proof container and hermetically sealed in a plastic bag. Additional support should be obtained by enclosing in an individual cardboard box.

A limited number of 701 Systems were produced for specific requirements, many installations of which have changed to the IBM 704 System.

General Motors Corporation

Two interpretive systems are used, Speed Co and ACOM. Speed Co is 3-address while ACOM is 2-address. Both provide for floating point arithmetic, transcendental functions, In-Out operations, B-boxes, and tracing all of which aid in coding and checkout.

Lockheed Aircraft Corporation

A general purpose system called FLOP, a contraction of Floating Octal Point, was developed at Lockheed by members of the Digital Computing Staff.

FLOP converts the 701 into an entirely different machine, one which performs all its operations in a "floating octal" system, but also permits all the normal 701 operations to be executed in fixed binary. The floating octal operations performed by the system are add, subtract, multiply, divide (all with real or complex numbers), $\log_8 x$, 8^x, sin x, $\sin^{-1}x$, and square root. The system also provides certain logical operations and control of the input-output devices in three number systems: binary, octal, and floating decimal.

This system was developed in order to obtain a minimum of elapsed time from when a new problem first enters the department to when answers are obtainable.

FUTURE PLANS

U. S. Naval Ordnance Test Station, China Lake

A modofication has been made to the system to allow asynchronous digital data to fill the entire storage unit at one time. Such data are fed from magnetic tape containing the digitalized version of analog information originating at the test equipment. The analog to digital conversion is done as a separate step, prior to entering the data into the computer.

INSTALLATIONS

U. S. Naval Ordnance Test Station
China Lake, California

United States Weather Bureau
Washington, D. C.

Boeing Aircraft
Wichita, Kansas

Douglas Aircraft Company, Incorporated
El Sequndo, California

Douglas Aircraft Company, Incorporated
2000 North Memorial Drive
Tulsa, Oklahoma

Douglas Aircraft Company, Incorporated
3000 Ocean Park Blvd.
Santa Monica, California

General Motors Corporation
Detroit, Michigan

Glenn L. Martin Company
Baltimore 3, Maryland

Lockheed Aircraft Corporation
Burbank, California

United Aircraft Corporation
East Hartford 6, Connecticut

University of California
Radiation Laboratory
Berkeley 4, California

IBM 702

IBM 702 Electronic Data Processing Machine

MANUFACTURER

International Business Machines Corporation

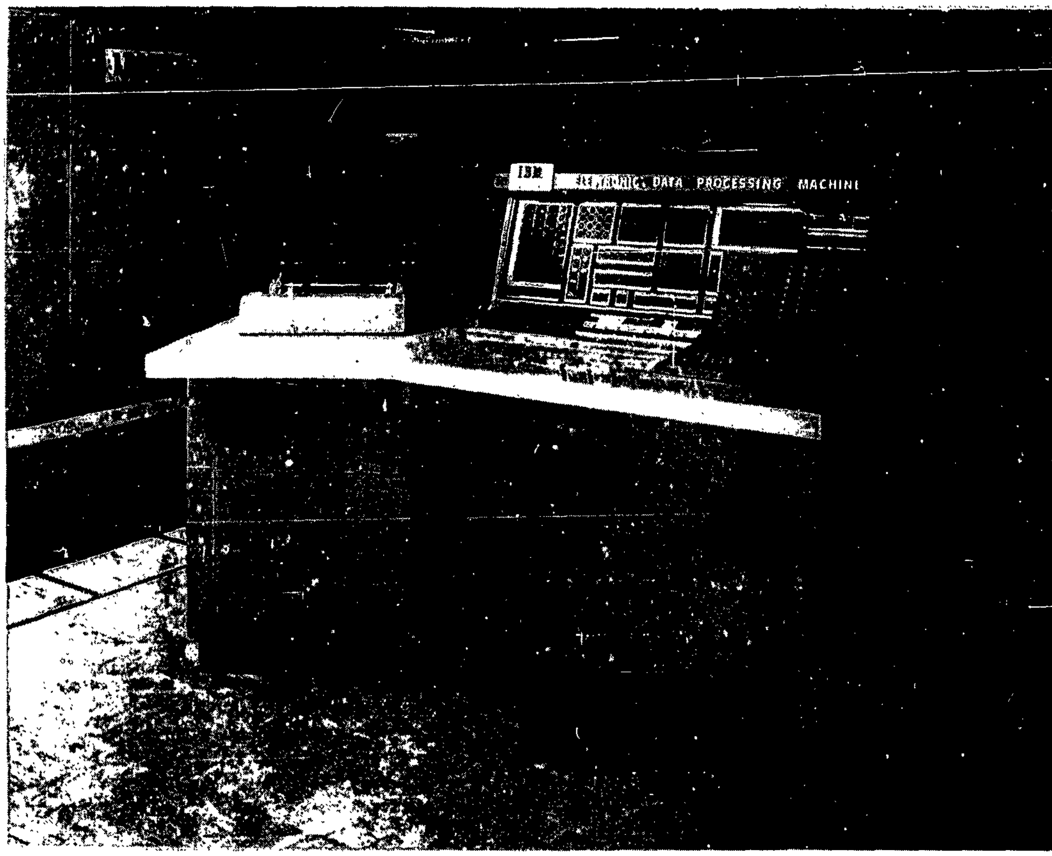


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

System is used for commercial (cost, inventory, production, accounting, sales, billing, etc) and for scientific (engineering design, mathematical models) applications.

U. S. Navy Aviation Supply Office

Commercial, inventory control.

Bank of America

Located at 500 Howard Street, San Francisco, the system is used for real estate loan accounting, installment loan accounting, accounts receivable accounting, corporate trust accounting, bond investments accounting, branch clearings (inter-branch debit and credit accounting), and branch activity surveys (personnel requirements).

Chrysler Corporation Service Parts Warehouse

Invoicing, cost of sales and inventory control.

Commonwealth Edison Company of Chicago

Customer billing and accounting.

General Electric Company, Hanford Atomic Products

Provide general data processing and computing service to entire plant, both commercial and scientific work.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal and alphabetical
Digits per word	Variable
Digits per instruction	5 characters
Instructions per word	No words
Instructions decoded	32
Arithmetic system	Fixed point

Floating point is programmable.

Instruction type	One address
Number range	± 256 decimal digits
Instruction word format	

X	X	X	X	X
Operation	Address			

Automatic built-in subroutines include store for print.

Autometic coding consists of the Autocoder System.

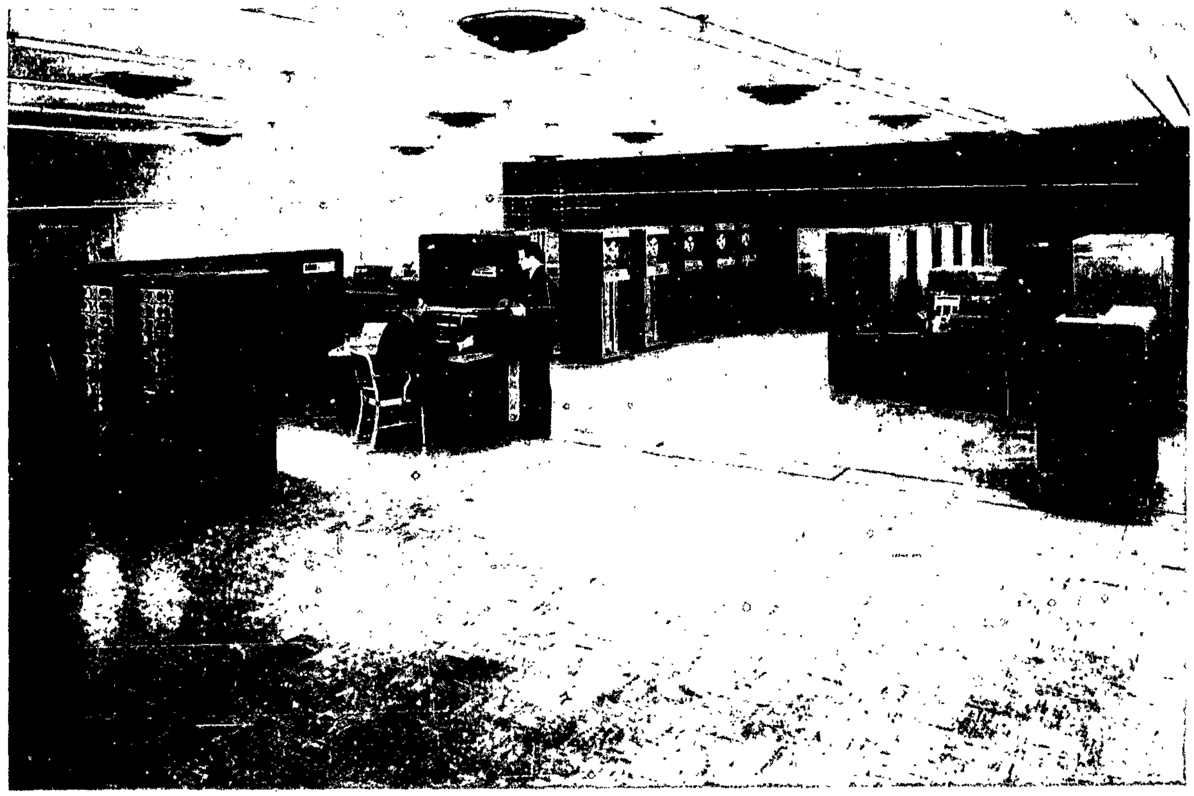


Photo by International Business Machines Corporation

There are two 256 - character accumulators.

The machine is not a fixed word length system. It is possible to have both variable field and variable record lengths. Consequently there are no "words". The characters are alphanumeric. Five characters are required to make up an instruction.

ARITHMETIC UNIT

The time required to add is 23 microseconds, excluding the storage access time. The time required to multiply is given by

$$23\ [N_p\ (N_c + 4) + 1\ ] + 115 \text{ microseconds.}$$

The time required to divide is given by

$$23\ [\ 10 + N_d + (N_d - N_r)(7.5K + 15)\ ] + 115 \text{ microseconds.}$$

Where

N_p = number of multiplier digits

N_c = number of multiplicand digits

N_d = number of dividend digits

N_r = number of divisor digits

$K = N_r$ if $N_r > 8$ and $K = N_r + 0.005(8 - N_r)$ if $N_r < 8$.

The arithmetic unit is constructed of vacuum tubes, crystal diodes and magnetic cores and operates serially by binary coded decimal character and parallel by bit.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	Alphanumeric Characters	Access Microsec
Magnetic Core	10,000	17
Magnetic Drum	60,000	8,120+40N

Magnetic drum has 300 sections of 200 characters each. N = number of characters.

Magnetic Tape	5,760,000	10,140+67N

No. of units that can be connected	10 Units
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Char/sec
Start time	10 Millisec
Stop time	10 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	200-2,400 Feet
Composition	Acetate or Mylar

Mylar is Dupont's registered name for its polyester film.

U. S. Navy Aviation Supply Office

System has magnetic core storage unit in lieu of electrostatic.

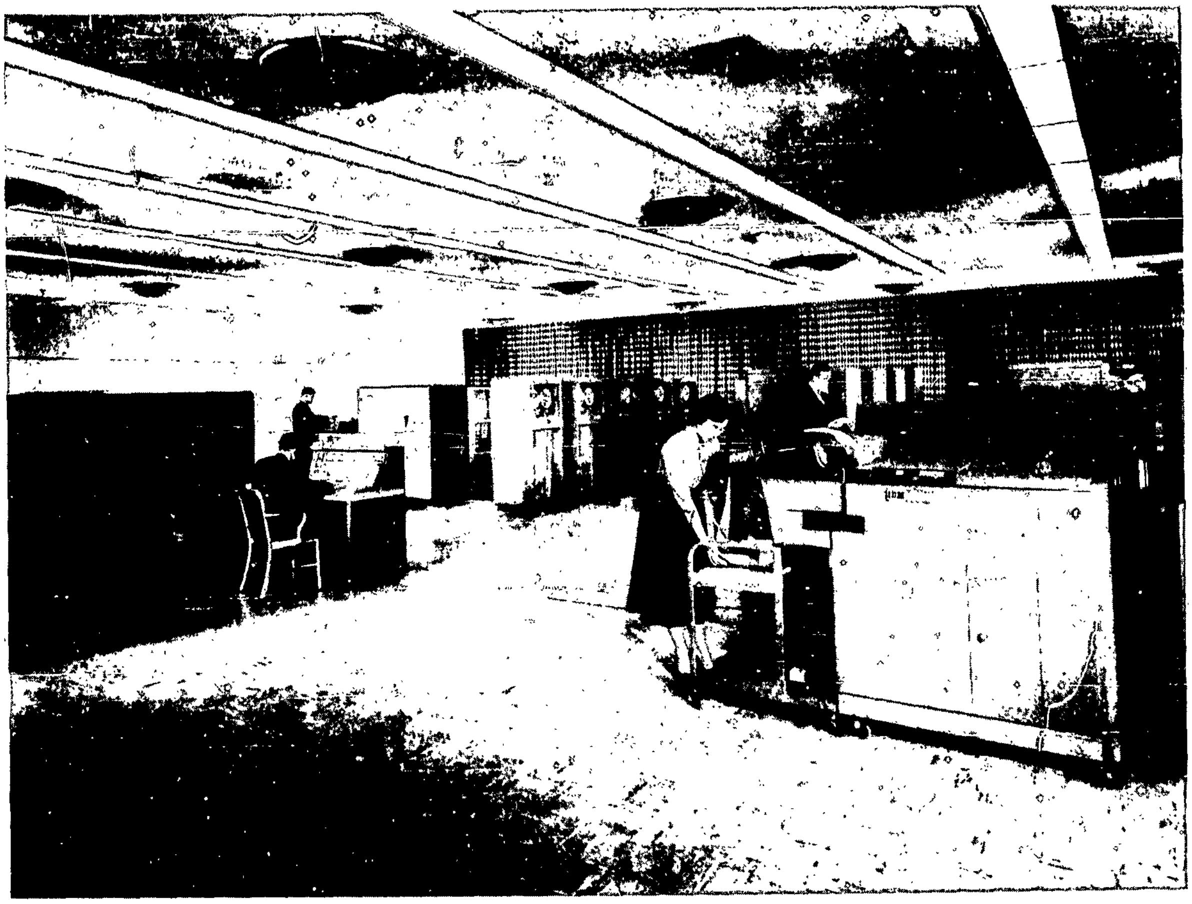


Photo by International Business Machines Corporation (Poughkeepsie)

Bank of America

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core Memory	Variable	20,000	17

Not a fixed word length system. Variable field lengths and variable record lengths are possible. Characters are alpha-numeric.

Chrysler Corporation Service Parts Warehouse System has magnetic core and magnetic drum.

General Electric Company, Hanford Atomic Products System has magnetic core, magnetic drum, and magnetic tape storage.

INPUT

Manufacturer

Media	Speed
Magnetic Tape	
Card Reader	250 cards/min
Operator Console	Manual
Magnetic	25,000 char/sec

U. S. Navy Aviation Supply Office

Magnetic tape unit operates at 200 char/inch and 75 inches/sec. Card reader operates at 250 cards/min at 80 char/card.

Bank of America

Media	Speed	
Magnetic Tape	75 inch/sec	1/2" 7-channel tape
Punched Card	250 cards/min	80 char/card

Card to magnetic tape conversion done on "off-line" basis.

General Electric Company, Hanford Atomic Products Operation

Card reader at 250 cards/min with off-line card to tape conversion. Magnetic tape speed is (10,000 + 67N) microseconds, where N is the number of characters.

OUTPUT

Manufacturer

Media	Speed
Magnetic Tape	
Card Punch	100 cards/min
Line Printer	150 lines/min
	500 lines/min
Typewriter	1,000 lines/min
	600 char/min
Magnetic Drum	25,000 char/sec

The IBM 1401 Data Processing System may be used for peripheral operations such as card-tape, tape-printer, and card editing at speeds of: card reading- 800 cards/min, card punching-250 cards/min and printing-600 lines/min.

Photo by General Electric Company Richland

U. S. Navy Aviation Supply Office
System has all above output systems.

Bank of America

Media	Speed	
Magnetic Tape	75 inch/sec	1/2" 7-channel tape
Punched Card	100 cards/min	80 char/card
Typewriter	600 char/min	
Printer	500 lines/min	120 print positions

Magnetic tape to card and tape to printer conversion done on "off-line" basis.

General Electric Company, Hanford Atomic Products
Magnetic tape to card and tape to printer conversion done on "off-line" basis.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Tubes	10,000
Tube types	10
Crystal diodes	17,000

Complement changes with configuration.

Bank of America
In addition to the above, the system has 165,000 magnetic cores. It utilizes tube types 6211, 5965 and 5687.

CHECKING FEATURES

Instruction
During the execution of an instruction, a character code error, an invalid operation part transfer, or an operation part interpretation, may be detected and indicated.

Machine
The machine check indicator is turned on when a character code error is detected during the execution of all instructions (except write, write and erase, read, and read check) in which information is read from accumulator storage or memory. Read-Write -- checks the transmission of data from all input units to memory. It also checks the transmission of all output data from memory to the drum, tape unit, card punch record storage, printer record storage, and typewriter.

Printer-Punch
This indicator reflects any error when information is punched in a card or when printed on the printer.

Overflow
The overflow check indicator is turned on during an add or subtract operation when the number of digits in the result is greater than the number of digits in the longer of the original fields. An overflow is indicated as a result of a round off operation if a

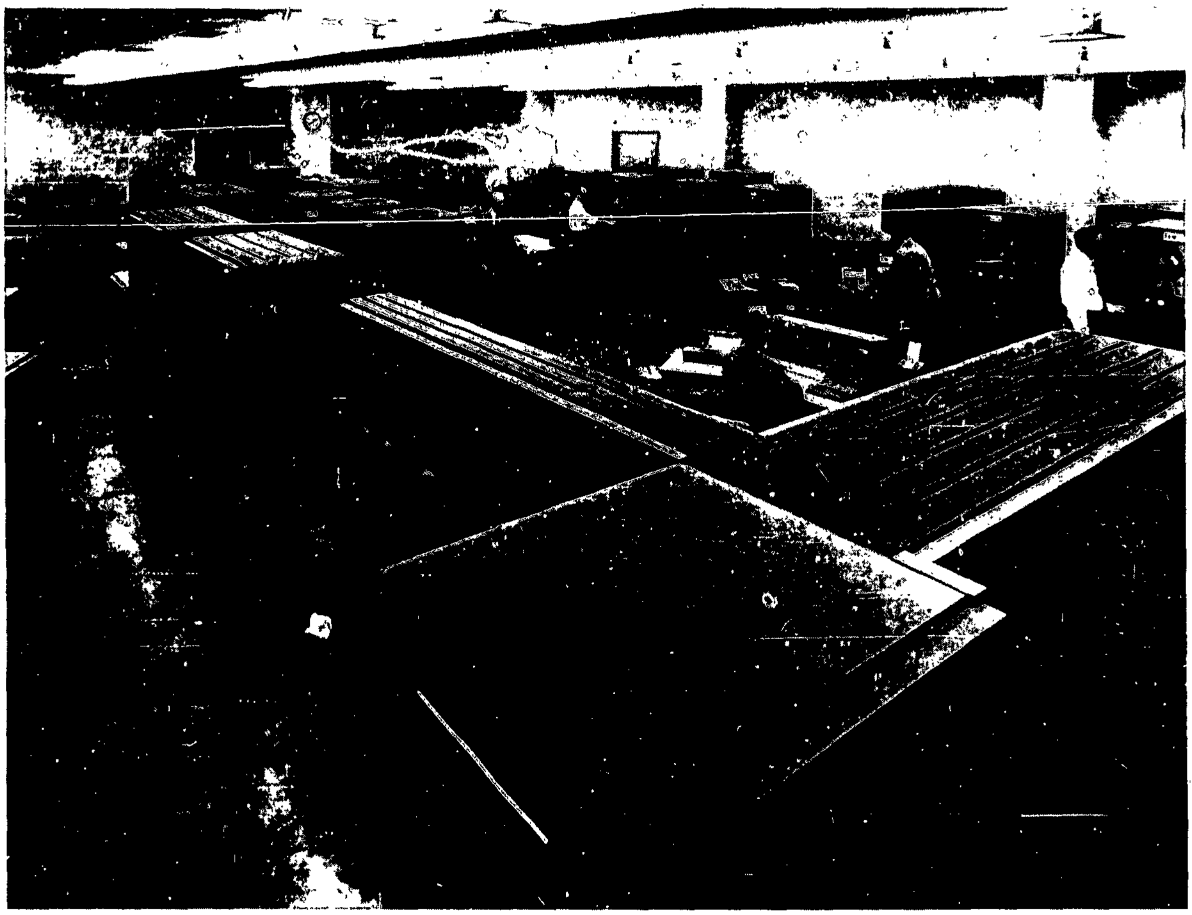


Photo by Commonwealth Edison Company, Chicago

carryover is made out of the highest order position of the original accumulator storage field.

Sign

The indicator turns on when a field addressed by an arithmetic instruction does not have plus or minus zoning over the right hand digit.

Bank of America

The following checks are made:

Odd-even redundancy
Read-write operations
Longitudinal redendancy on magnetic tape processing.

General Electric Company Hanford Atomic Products Operation

Parity check using 7 bit code with only six bits of real data is used for all internal operations and all input-output. All corrective action can be programmed or machine can be set to stop on error at the programmer's discretion.

Normally operated with internal error detection set to stop, but with input-output error correction programmed.

Photo by Bank of America, San Francisco

POWER, SPACE, WEIGHT, AND SITE PREPARATION

			Manufacturer						
			Power	Current	Heat	Weight	Size	(Nearest	Inch)
Type	Name	Qty.	Kw	Amps.	B.T.U.	lbs.	Width	Length	Height
702	Central Processing Unit	1	25.0	87	85,000	5,291	147	139	63
	Main Power Unit	1				2,961	34	61	66
	Console	1				508	35	61	46
712	Card Reader	1	5.0	17	17,000	1,053	43	28	49
756	Card Reader Control Unit	1				1,712	27	57	64
717	Printer	1	9.0	31	30,700	2,244	30	64	47
757	Printer Control Unit	1				1,866	27	57	64
722	Card Punch	1	7.6	26	26,000	1,176	25	53	50
758	Card Punch Control Unit	1				1,866	27	57	64
732	Drum Unit	1	6.9	24	23,600	1,775	27	62	64
	Drum Power Supply	1				1,646	27	40	64
727	Tape Unit	10	13.0	45	44,200	9,110	26	24	66
752	Tape Control Unit	1	8.4	29	28,700	1,636	27	57	64
			74.9	259	255,200	32,844			

Approximately one Ton of air conditioning required for 12,000 B.T.U.

U. S. Navy Aviation Supply Office
System requires 75 Kw, occupies 19,494 cu ft, 2,052 sq ft, measuring 57 ft by 36 ft by 9 1/2 ft. The system weighs 33,000 lbs. The air conditioning consists of a 40-Ton unit and a 15-Ton unit, occupying 3,168 cu ft of space and 288 sq ft of area, measuring 12 ft by 24 ft by 11 ft.

Bank of America

System requires 93 Kw, 208V, 3 phase, 60 cycles/sec, 16,000 cu ft, 2,500 sq ft, measuring 55 ft by 45 ft by 8 ft. Air conditioner requires 66 Kw, 2,552 cu ft, 319 sq ft, measures 29 ft by 11 ft by 8 ft, and has a capacity of 60 Tons. The air conditioning equipment designed to accommodate requirements for comfort conditioning of engineering, mail handling, tabulating, and office personnel and space. Building modifications were required, since neither building was specifically designed for computer operations. False ceilings, plenums and partitions were installed for air supply, negative pressure, and temperature control. Power distrubution is provided by underfloor conduit and pull boxes.

General Electric Company Hanford Atomic Products

Power service to system is 300 amps, 208 volts, 3 phase for computer and 105 amps, 440 volts, 3 phase for air conditioner. The machine room is 40 ft by 60 ft and the air conditioner requires an area of 20 by 20 ft. The air conditioner capacity is 52 Tons. Power consumption has been stated in terms of service supplied rather than actual machine consumption. The space required is a function of the amount of engineering and observation space and other miscellaneous working areas which are considered necessary or desirable to have in addition to the actual cubic footage of the equipment.

PRODUCTION RECORD

Manufacturer

Number produced Over 13

There are no 702 Systems in production, at the present time. A limited number of 702's were produced. The successor to the 702 was the IBM 705.

COST, PRICE AND RENTAL RATES

Manufacturer

Type	Name	Monthly Rental	Base Purchase Price
702	CPU (Model 1)	$6,900	$358,800
712	Card Reader	750	36,800
717	Printer	1,400	55,000
720	Printer (Model 1)	1,400	56,900
722	Card Punch	800	43,300
727	Magnetic Tape Unit	500	18,200
730	Printer (Model 2)	3,900	210,500
732	Magnetic Drum Storage	2,300	113,000
735	Printer Control	600	32,500
742	Magnetic Drum Power	500	26,500
743	Power Supply	1,000	52,000
752	Tape Control	550	28,600
756	Card Reader Control	300	18,000
757	Printer Control	650	44,000
758	Card Punch Control	600	36,000
760	Control and Storage	2,500	111,000

There is no predetermined grouping of equipment. Combinations of above are available based on requirements.

The base purchase price is used in computing the discounted purchase price based on the age of the installed machine. A published discount schedule is available from IBM.

Maintenance contract available.

U. S. Navy Aviation Supply Office

Prime shift monthly rental rate for system is $30,200.

Bank of America

Rental rate is $9,900 for basic system and $15,475 per month for additional equipment.

Commonwealth Edison Company of Chicago

Serial No.	Description	Qty	Unit Rate	Monthly Rental (Primary Shift)
702	Central Processing Unit	1	$9,900	$9,900
712	Card Reader	2	770	1,540
756	Card Reader Control Unit	2	300	600
717	Printer	2	1,200	2,400
757	Printer Control Unit	2	600	1,200
722	Card Punch	2	750	1,500
758	Card Punch Control Unit	2	325	650
727	Magnetic Tape Units	17	550	9,350
752	Tape Control Unit	1	550	550
776	Record Storage Unit	2	1,850	3,700
732	Magnetic Drum	1	2,800	2,800
			Total	$34,190

2nd and 3rd shift rental charged at 50% of above rates.

General Electric Company Hanford Atomic Products

Rental rate is $34,900/month for system, including average extra shift rental. Rental rate for punched card machines, including extra shift but excluding key punches and verifiers is $2,175 per month.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Engineers	4	7	10

One console operator and 2 floor operators per shift are required. Programmers vary from 4 to over 30, depending on number of applications on system.

Education training, program testing, technical assistance on all phases is available from the manufacturer.

U. S. Navy Aviation Supply Office

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Engineers	3	6	9
Operators	9	12	15

The operators are divided as follows: For first shift, 3 are on main frame, 3 auxiliary and 3 supervisory. For second shift, 3 main frame operators are required and for the third shift three operators are required for the main frame.

Bank of America

	One 8-Hour Shift	Second 8-Hour Shift	Third 8-Hour Shift
Supervisors	1		
Librarians	1		
Operators	1	1	1
Engineers	1	1	
In-Output Opera	1	1	

Engineers are provided by IBM. Mail clerks, key punch operators and typists are not included among the typical personnel, since these positions are not intrinsic to the computer operation as such. Personnel covers operation on a 5-day-a-week basis.

Operation tends toward open shop.

Currently no training is in progress. Present key personnel have, however, attended IBM and Bank sponsored courses prior to their initial assignments.

Commonwealth Edison Company of Chicago

Three 8-hour shifts require 9 engineers and 18 technician-operators.

General Electric Company Hanford Atomic Products
Three 8-hour shifts require 5 engineers and 8 technician-operators. The engineers are employed by IBM. Personnel covers operation on a 7-day-a-week basis.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

U. S. Navy Aviation Supply Office
Approximate reliability is 0.85, where reliability is obtained by subtracting the sum of machine error time, the unscheduled maintenance time and the tape trouble time, from the available time and dividing the difference by the available time. The above figure is based on the period from July to September 1956.

Bank of America
Average error-free running period 2 Hours
Good time 12.56 Hours/Day
Attempted to run time 14.13 Hours/Day
Operating ratio (Good/Attempted to run time) 0.89
Above figures based on period 1 Jul 56 to 30 Sep 56
Passed Customer Acceptance Test 20 Aug 55
Of the 0.11 lost in the operating ratio above, approximately 0.037 was due to main frame down time, 0.037 was due to tape unit down time, 0.030 to corrective restart time and 0.006 was due to tape remake time.

Bank of America
Average error-free running period 100 Hours
Good time 101 Hours/Week (Average)
Attempted to run time 102 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.99
Above figures based on period 1 Jun 60 to 31 Aug 60
Passed Customer Acceptance Test 20 Aug 55
Time is not available for rent to outside organizations.
A high degree of experience in both the operating and maintenance personnel has resulted in the virtual elimination of "down" time.

Chrysler Corporation Service Parts Warehouse
Productive time, maximum 0.94
Productive time, minimum 0.78
Based on period 5 Apr 56 to 27 Sep 56
Passed Customer Acceptance Test 22 Aug 55

Commonwealth Edison Company of Chicago
Average error-free running period 4-6 hours estimate
Good time 18 Hours
Attempted to run time 20 Hours
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 1 Oct 56 to 31 Dec 56
Passed Customer Acceptance Test Jul 55

General Electric Company Hanford Atomic Products
Average error-free running period 68 Hours
Good time 1,275 Hours
Attempted to run time 1,301 Hours
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period 1 Aug 56 to 14 Oct 56
Passed Customer Acceptance Test 1 Jul 55
Core storage unit installed July 1956. Preventive maintenance is scheduled 4 hours/day for 4 days per week. Over the weekend 68 hours elapse between scheduled maintenance sessions.

The Prudential Insurance Company of America
It is expected that conversion from electrostatic storage to core storage will further reduce unscheduled maintenance from an overall average of 5.8% experienced between 14 November 1955 and 31 August 1956. Two-shift operation occurred during that period.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
Inter-tape-card-printer conversion.
Rental rates include servicing, educational assistance through a 702 school, special representatives and programming service.
System was replaced by the Type 705.
Autocoder system is used.
Component units, which have various functions, are housed in a half-dozen or more separate cabinets, the number of each type depending upon the user's needs. The use of these separable units allows freedom in the design of the data processing system. Essential components include the arithmetical and logical unit, the operator's control console, magnetic tape units, an input card reader, and an output printer and card punch. Often a magnetic drum will also be included in an installation, or several drums might be used.

Bank of America
Outstanding features are the inter-tape card-printer conversion and the expandable memory.
Magnetic tapes receive an internal label under program control as well as a manually produced external label. Tapes are stored in a fire-proof tape vault which has humidity and temperature control. Critical "back-up" tapes are sent daily to off-premise storage locations.

FUTURE PLANS

Bank of America
Our systems will be replaced by IBM Type 7070 and 1401 Electronic Data Processing machines during the first part of 1961. All applications on the IBM 702 are currently being programmed for these new computing systems. Research is also being done on other applications within the banking field.

Commonwealth Edison Company of Chicago
System was replaced by an IBM Type 705 Electronic Data Processing Machine in March 1957.

INSTALLATIONS

U. S. Navy Aviation Supply Office
Philadelphia 11, Pennsylvania

Bank of America
500 Howard Street
San Francisco, California

Chrysler Corporation
Detroit 31, Michigan

Commonwealth Edison Company
72 West Adams Street
Chicago 90, Illinois

Ford Motor Company
Dearborn, Michigan

General Electric Company
Hanford Atomic Products Operation
Richland, Washington

Monsanto Chemical Company
St. Louis, Missouri

Prudential Life Insurance Company of America
Newark, New Jersey

IBM 704

IBM 704 Data Processing System

MANUFACTURER

International Business Machines Corporation

Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

Scientific and commercial data processing.

USA Ballistic Missile Agency Redstone

Located at Redstone Arsenal, Alabama. Both systems are used for the solution of scientific problems.

USA White Sands Missile Range Control Office

Located at Building 1526, White Sands Missile Range, New Mexico, the system is used for guided missile simulation and reliability studies.

USA White Sands Missile Range Integrated Range Mission

Located in Building 841, Holloman AFB, New Mexico, the primary use is for computations incident to conversion of range flight test data to engineering formats. Secondary usage is for computations of problems associated with flight simulation and a small amount of general purpose computing for range customers.

USN David Taylor Model Basin

Located at Applied Mathematics Laboratory, Washington, D. C. The system is used for the solution of naval engineering and scientific problems.

USN Ordnance Laboratory, White Oak

Located in the Mathematics Department, Naval Ordnance Laboratory, White Oak, Maryland, system is used for scientific applications: e.g., trajectories, material studies, wind tunnel data reduction, and explosive phenomena.

USAF Eglin Air Force Base

Located in Building 100, Room 108, Eglin AFB, Fla. The system is used for the evaluation of the Semi Automatic Ground Environment System (SAGE), the computation of theoretical ballistic trajectories, for data reduction, e.g., the solution of three station Cinetheodolite problems and evaluation of data collected on Electronic Counter Measures (ECM) tests, and for civilian payroll computation.

USAF Edwards Air Force Base

Located at Flight Test Center, Edwards Air Force Base, Cal. Approximately 70% of the total operational system time is utilized in support of a complete spectrum of scientific applications associated with the testing of all aircraft, rocket engines, and their systems components. In addition, support is provided to Army, Navy, NASA, and numerous contractor organizations utilizing facilities at the Air Force Flight Test Center (AFFTC). Numerous data reduction applications are being accomplished utilizing the computing system to reduce performance and stability data on aircraft undergoing category tests and missiles undergoing static and reliability tests. In addition, numerous range data; namely, Askania, Akeley, Nike Radar, Mod II Radar, Metric-Camera, and oscillographic data, are processed in support of these tests. Other applications being accomplished are Experimental High Speed Track Data Reduction, Power Spectral Density Studies, Heat Transfer Analysis, Rocket-Orbital Trajectory Analysis, etc. The remainder of the computer utilization time is in support of the management type applications; namely, supply, cost accounting, civilian personnel skills inventory, military personnel records, etc.

USAF Headquarters Strategic Air Command.

Located at Offutt Air Force Base, Nebraska. Fields of Application: target analysis and mission planning target system maintenance and analysis planned damage assessment, determination of optimum aiming points, future force structure requirement studies, missile trajectory computations, airborne alert flight planning, computation of war order

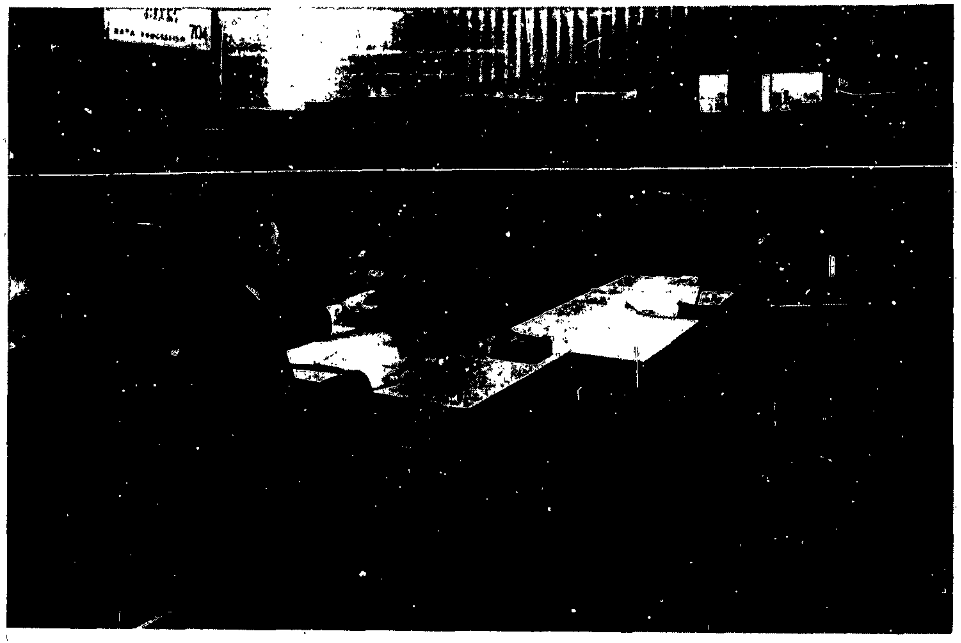


Photo by International Business Machines Corporation

option sheets, plan evaluation, including war gaming and command post exercises, maintenance of SAC readiness, EWO maintenance and update, base status and aircraft readiness, weapons inventory, weather forecasting, ECO control, flight/force following, lost base evaluation, plan revision, actual damage assessment, restrike planning.

USAF Kirtland Air Force Base

β Located in Building 1017, Hq 4925th Test Group (A), Kirtland AFB, New Mexico, the prime use of the high-speed electronic computer at Kirtland AFB is for scientific applications. Both practical and theoretical data are processed through the computer in order to further USAF progress in the application of all phases of nuclear weapons employment, military implications of various nuclear weapons strategies, and other studies vital to the defense of the United States.

Argonne National Laboratory

The system is used primarily for scientific computing.

Bureau of Flight Standards Federal Aviation Agency

Located in Hangar No. 9, FAA Aeronautical Center, Oklahoma City, Okla., the system is used for flight check and evaluation of air navigational aids.

NASA, Ames Research Center

Located at Moffett Field, Cal., 95% of use time is spent doing theoretical problems relative to aeronautical and space research such as heat transfer problems, boundary layer calculations, launch, rentry, and orbit problems, calculation of flow fields in air and other gases, calculation of lift and drag for theoretical configurations, behavioral study of contemplated designs for missiles and rockets, calculations of gas properties for given pressure and temperature ranges. The remaining 5 percent is spent in data reduction for wind tunnels or in a minor amount of bookkeeping for the 704 staff.

NASA, Lewis Research Center

Located at the NASA-Lewis Research Center, 21000 Brookpark Road, Cleveland 35, Ohio, the system is used for the solution of problems submitted by mathematicians and scientists in the fields of nuclear research and development, rocket components and systems research and development, satellite and interplanetary orbit calculations, materials research, etc.

National Bureau of Standards

Located in Building 42, Washington, D. C., the applications are scientific, engineering, and business.

National Security Agency

Located at Ft. George G. Meade, Maryland, the system is used for mathematical calculations.

Tennessee Valley Authority

Located at 11 Old Post Office, Chattanooga, Tenn, the system is used for hourly computation of economic generation schedule for TVA power system, electric load flow studies, electric load and revenue forecasting, electric sales statistics, payroll, water storage calculation and evaluation, hydraulic data studies, flood control studies, forest survey, chemical research studies, navigation (including river traffic) studies, and linear programming applications.

Allis-Chalmers Manufacturing Company

Located in Milwaukee, Wisconsin, the system is used for engineering calculations, scientific calculations, experimental data reduction, and simulation.

AVCO Corp Research and Advanced Dev. Div.

Located at 201 Lowell St., Wilmington, Mass, the system is used for the solution of engineering problems by numerical methods; specifically, systems of ordinary and partial differential equations

Photo by Flight Simulation Laboratory, WSMR

(trajectories, aerodynamic flow, heat transfer, stress analysis), variational problems (optimization of trajectories), data processing, etc.

Bell Aerosystems Company

Located at the Wheatfield Facility, Niagara Falls, N.Y., the system is used for rocket engine design, rocket fuel combustion analysis, aircraft and missile performance, missile and satellite trajectory analysis, flutter vibration and aeroelasticity studies, heat transfer computations, data reduction, production control, and inventory control.

Bell Telephone Laboratories

Located at 3D-075, Whippany, N. J., the system is used in the sage military system, missile simulation projects, electronic switching applications, and mathematical research problems.

Bell Telephone Laboratories

Located at Murray Hill, New Jersey, the system is used for scientific and engineering applications, including: computer research, numerical analysis, statistical analysis, logical design, simulation of digital system, analysis of audio and visual signals, and simulation of missile systems.

Bendix Systems Division, The Bendix Corporation

Located at Data Processing and Displays Dept., Bendix Systems Division, Ann Arbor, Mich. Scientific applications include: real time input/output for intergrating human decisions and control functions in simulated control loops; simulation of digital guidance and control systems, simulation of tactical computer functions, reliability prediction and development program control operations.

CEIR Incorporated

Located at 1200 Jefferson Davis Highway, Arlington 2, Va., the system is used for linear programming, file maintenance and information retrieval, trajectory calculations, language translation, business data processing, and other applications.

Convair-Fort Worth Division of General Dynamics

Located at Forth Worth, Texas, the system is used for the solution of engineering problems in the design and testing of aircraft and missiles, preparation of data for the numerical control of machine tools, and the solution of problems arising in research in nuclear physics and operation of nuclear test facilities.

Cornell Aeronautical Laboratory, Inc.

Located at 4455 Genesee Street, Buffalo 21, N.Y. The system is used for the simulation of military systems, the solution of problems resulting from scientific investigation, and data processing.

Convair-San Diego

Located in Building 54A, Plant I, San Diego, Cal. The system is used for flight simulation, flutter analysis, flight data reduction, numerical milling, missile trajectory calculation, satellite surveillance, wind tunnel data reduction, radome predictions, and interceptor mission calculations.

Douglas Aircraft Company

Located at 3000 Ocean Park Blvd, A-260, Santa Monica, Cal., the system is used for strength analysis, missiles trajectories, aerodynamic stability, aerodynamic performance, dynamic response, thermodynamic analysis, weight control, and propulsion analysis.

Douglas Aircraft Company

Located at A-850, Santa Monica, Cal., the system is used for flight test data reduction, aerodynamic certification studies, and flutter and gust load analysis.

Douglas Aircraft Company

Located at B-250, El Segundo, Santa Monica, Cal. The system is used for strength analysis, trajectories, aerodynamic stability, dynamic response, thermodynamic analysis, weight control, and propulsion analysis.

General Electric Company

Located at Temple, Arizona, the system is used for business and scientific problems including payroll, inventory, traffic assignment and simulation.

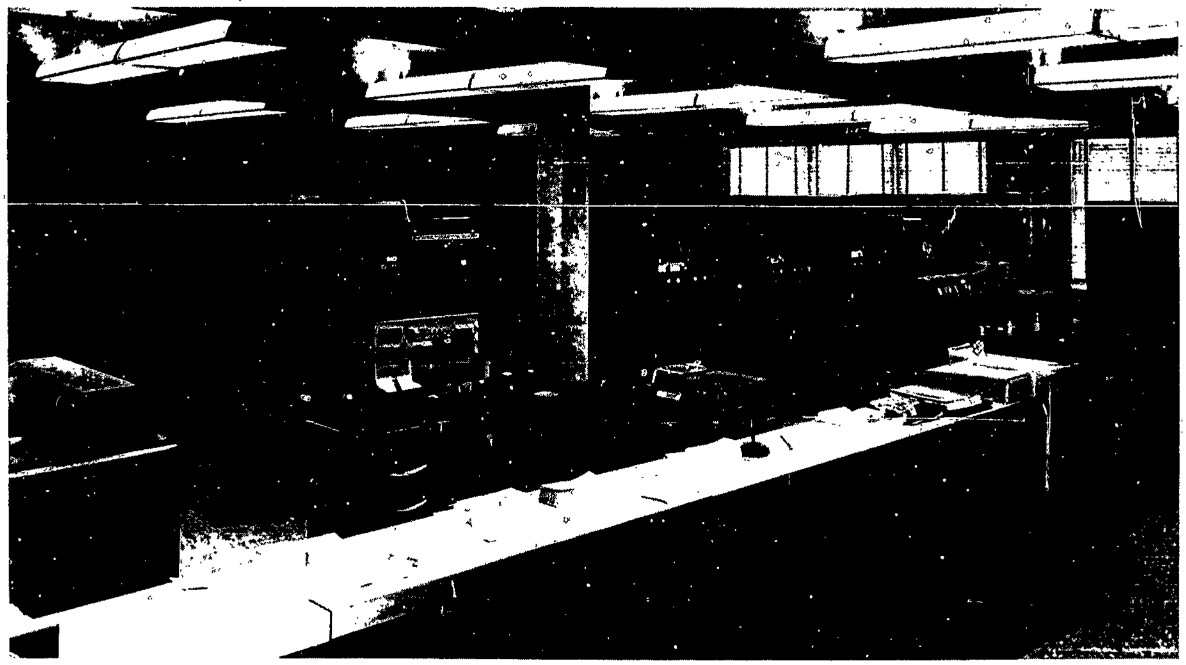


Photo by David Taylor Model Basin

General Electric Company Evendale
Located in Building 305, General Electric Company, Evendale 15, Ohio, the system is used in all areas of application in scientific and business fields.

General Electric Company Schenectady
Located at Schenectady, New York. The system is used for product design, product performance, shop simulation, payroll, and general accounting.

General Motors Corporation
Located in the Engineering Research Building, General Motors Technical Center, Warren,Michigan. The system is sued for test cell data reduction, engine and transmission design (IC, gas turbine and free piston), numerical tool control, curve plotting, reactor studies, missile guidance systems, vehicle simulating, bearing load computations, aircraft propeller design, and component and system reliability.

Allison Division, General Motors Corporation
Located at Plant No. 8, Indianapolis 6, Indiana. The system is used for mathematical support of R and D activity including orbital and trajectory analyses, thermodynamic calculations, secondary power system designs, simulation, reliability studies and data reduction.

Allison Division, General Motors Corporation
Located at P. O. Box 894, Indianapolis 6, Indiana. The system is used for Material Procurement, including: daily sales release reports, material schedules, commitments, priced inventory; for Production Control, including: daily availability, production schedules, manpower and machine loading; for Accounting, including: cost of production, cost of sales, standard time, manufacturing expense; for Hourly Payroll; for Aircraft Spare Parts, including: parts scheduling, parts status, daily shipments, and invoicing; for Reliability, including: engine and parts history data and field service reporting; and for engineering calculations.

Grumman Aircraft Engineering Corporation
Located in the Engineering Department, Research Section, Bethpage, New York. The system is used for flutter and vibration analyses, structural investigations, engine performance, trajectory studies, operation research studies, simulation numerically controlled machines, research projects, numerous other problems concerned with the design and manufacture of airframes and missiles.

Gulf Research and Development Company
Located at the Gulf Research Center, P. O. Drawer 2038, Pittsburgh 30, Pennsylvania. The computer primarily serves as a research tool for the various activities of the Gulf and Development Co., viz: automotive engineering, geology, geophysics, process research, product development, petroleum and reservoir engineering, physics, chemical and physical analysis, and administration.
The computer is also used for various activities of the parent Gulf Oil Corporation when the problems are too large for the other computers belonging to the corporation.

International Business Machines, Product Development Laboratory, Poughkeepsie
Located on High Street, Poughkeepsie, New York. The system is used for design automation in back panel wiring routing, and for scientific computation, e.g., circuit analysis, reliability and simulation programs, design automation - logic page updating, printing and checking - see Tech. Note TN 00.01110. 416 and Technical Publication TR 00.0110. 72, engineering records - parts usage and maintenance program, engineering change control for 700/7000 series equipments.

Photo by USN Ordnance Laboratory, White Oak

IBM GPD Development Laboratory, Endicott
Located at GPD Development Laboratory, Endicott, New York. The system is used for mathematical, statistical, and engineering analysis, research and advanced design, design automation, and timing and Op code simulation of proposed computers.

IBM Service Bureau, San Jose
Located at IBM Plant, Bldg. 10, Room 308, Monterey and Cottle Roads, San Jose, California. The system is primarily a customer usage facility.

IBM Research Center, Yorktown Heights
Located at Horktown Heights, New York. General scientific computing and data processing arising in the work of a major industrial research organization.

Lockheed Aircraft Corporation, Marietta
Located at Marietta, Georgia. The system is used for aerodynamics, thermodynamics, vibration and flutter, elasticiy, weight and inertia analysis, nuclear physics, missile trajectory simulation, aircraft performance studies, flight test data reduction, numerical lofting, preparation of control media for numerically controlled milling machines, manpower forecasting, and a variety of other applications.

The Marquardt Corporation
Located at 16555 Saticoy Street, Van Nuys, Cal. The system is used for general scientific computing in support of company engineering and research efforts, engineering data reduction, management data processing, and computing service to outside organizations. (Government and Private Industry).

The Martin Company, Denver
Located at Waterton Facility of Martin, Denver, Colorado. The system is used for primary use of the computer system in the design of a missile system and in particular the following engineering applications: performance trajectories, structural analysis, propulsion analysis, guidance and control analysis. Other areas of application are test data reduction and data processing of large information files.

North American Aviation, Inc.,
Located at 4300 East Fifth Avenue, Columbus 1 , Ohio, the system is used primarily for general engineering and scientific applications. Prepares input to numerically-controlled milling machines, via APT. Data reduction for wind tunnel, flight test, and laboratories. Commercial data processing, material inventory, spares inventory, logistics inventory, tooling statistics, engineering statistics, payroll recapitulation and summaries.

Pratt and Whitney Aircraft
Located in the Office Area, Second Floor, Florida R and D Center, United, Florida. The systems uses are Scientific and Technical: (data reduction, design, performance, statistical, and other analytical studies necessary for the manufacture, testing, and development of jet and rocket engines) and Commercial: (Shop loading, wage and salary, and payroll applications).

Rand Corporation
Located at 1700 Main Street, Santa Monica, Cal. The system is used for the solution of orbit and trajectory problems, differential equation systems, war games, logistics simulations, and cost analyses.

Raytheon Company, Bedford
Located at the Systems Laboratory, Missile Systems Division, Raytheon Company, Bedford, Mass., the system is used for the computation of missile trajectories, design of missile components, analysis of missile systems, and other engineering applications.

Republic Aviation Corporation
Located at Farmingdale, New York, the system is used for corporate engineering-scientific programming-analysis including space studies (trajectories, reentry and tracking analysis); scientific research

Photo by USAF Edwards Air Force Base

(plasma propulsion and nuclear reactor analysis); aircraft design (aerodynamics, stress, thermodynamics); flight test data reduction; computer simulation. It is also used for corporate business data processing programming-analysis including payroll, accountability, manufacturing control, applied mathematics including numerical analysis, operations research and physical mathematics, and for programming techniques including scientific and business automation programming systems, i.e., SAP, FORTRAN, SURGE, Numerical Controls.

Sandia Corporation

Located in Building 880, Department 5240, Sandia Corporation, Albuquerque, New Mexico. The system is used for the computation of scientific data.

Socony Mobil Oil Company

Located at 150 East 42nd Street, New York 17, New York. The system is used for optimization of refining, distribution, and production by means of linear programming, refinery process unit design calculations, simulation of refining operations, financial analysis of proposed capital investment, sales forecasting, product cost determination, sales analysis, reservoir studies, prediction of future production, and general mathematical research.

Standard Oil Company of California

Located at 225 Bush Street, San Francisco, Cal. The system is used for technical, scientific and business problem solving for major functional areas of Standard Oil Company of California operations, including economics, finance, distribution, supply, exploration, producing, manufacturing, engineering and research.

Standard Oil Company of Indiana

Located at 2400 New York Avenue, Whiting, Ind. The system is used in linear programming (refinery scheduling, gas blending), product analysis, and operational problems (oil refining plants, line sizing, automatic controls, pilot plants, steam and water distribution, pipe flexibility, other engineering and chemical problems.)

TEMCO Electronics and Missiles Company

Located in the Engineering Building, Garland, Texas, the system is used for scientific requirements to support engineering and electronics department requirements; accounting and manufacturing data controls; payrolls, work in process, inventory analysis, and manufacturing controls, etc.

United Aircraft Corporation

Located at the Research Laboratories, UAC, East Hartford, Connecticut, the three systems are used to provide digital computations for the design, development, and performance of aircraft products, provide computation for the field of numerical control of machine tools, provide computation services for the AF 433L weather contract, and perform computations for direct outside contracts.

Chance Vought Aircraft, Incorporated

Located in Dallas, Texas, the system is used for astronautics, arrested landing, numerical controlled tools, structure analysis, data reduction, production control, simulation, weight accounting, operational analysis, data processing, reliability, flutter analysis, performance calculation, trajectories, and space and orbit analysis.

Westinghouse Electric Corporation

Located in Baltimore 3, Maryland. The system is used for weapons systems engineering design, simulation and evaluation, computer logic evaluation and design, other computer simulations, linear circuit analysis, inverse Laplace transform, space trajectory computations, satellite predicitions, radar antenna design investigations, mathematical techniques,

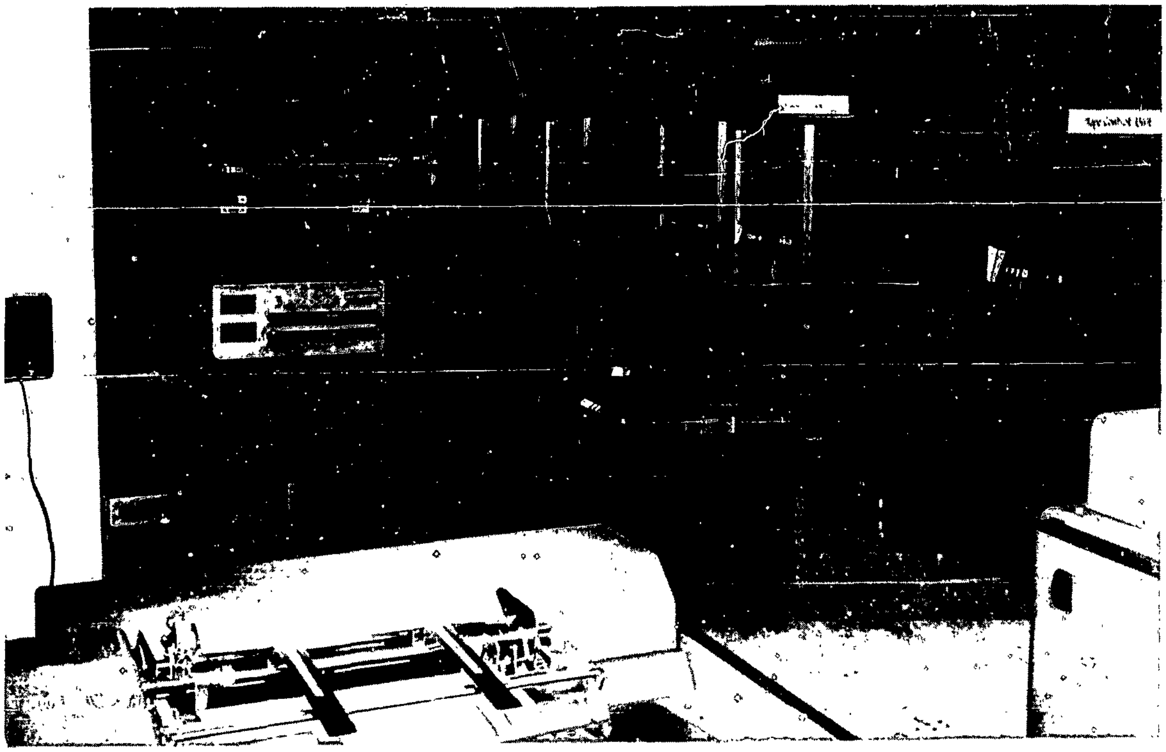


Photo by Mathematical Services Laboratory, Eglin Air Force Base, USAF

Westinghouse East Pittsburgh
Located at 4L39, East Pittsburgh, Pennsylvania. The system is used for performance analysis, electrical apparatus design, and electrical apparatus systems simulation.

California Institute of Technology, Jet Propulsion Laboratory
Located at Pasadena, California. The system is used for all problems of scientific type, trajectory simulation including power flight and interplanetary, lunar, near earth satellite trajectories, miscellaneous problems from chemistry, physics, structures, propulsion, etc., including temperature distribution calculations, theoretical performance calculation for chemical propulsion systems, structural design, control systems, nuclear calculations, propulsion test data reduction, and space science data reduction.

Midwestern Universities Research Association
Located at 2203 University Ave., Madison, Wis., the system is used for designing high energy particle accelerators.

Ohio State University
Located in Columbus, Ohio. The system is used for training, engineering computations, research in programming methods, and research in numerical analysis.

Texas Engineering Experiment Station
Located in the Data Processing Center Building, College Station, Texas, the system is used for teaching, research, computing support for research projects, and assistance to industry.

University of California, Los Alamos
Located at Los Alamos, New Mexico, the system is used for general scientific problems dominated by hydrodynamics and neutronics problems, research in numerical analysis, and research in automatic coding and programming languages.

University of California, Berkeley
Located in Campbell Hall, University of California, Berkeley, California, the system is used for research for all campus departments.

University of Michigan
Located at Computing Center, Ann Arbor, Michigan. The system is used for instructional and research use of the computer involving scientific computation from many fields.

NASA Lewis Research Center
Located at the NASA Lewis Center, 21000 Brookpark Road, Cleveland 35, Ohio, the system is used for the reduction of experimental data from wind tunnels, test stands, rocket stands, etc. Engineering and scientific analysis-type problems. Experimental data is recorded on automatic recorders of our own design. The punched paper tapes and/or magnetic tapes are fed into the computer, calibrated, and mathematical operations carried out to produce the qunatities specified by the test engineer. Scientific problems of all types are punched into paper tapes by a flexowriter, fed into the computer, and the mathematical operations specified by the programmer are performed.

Photo by USAF SAC Control Center, Offutt AFB

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system		Binary
Binary digits/word		36
Binary digits/instruction		36
Instructions/word		1
Instructions decoded		91
Arithmetic system		Fixed and floating point
Instruction type		One address
Number range	Fixed	$-(2^{35}-1) < N < (2^{35}-1)$
	Floating	$-10^{38} < N < 10^{38}$

Instruction word format

Oper Code	Flag		Tag	Address
S,1 11	12 13		18 20	21 35

Op	Decrement	Tag	Address
S,1 2	3 17	18 20	21 35

Automatic coding includes Fortran and SAP (Symbolic Assembly Prog).

There are 3 index registers and 3 arithmetic registers, i.e. accumulator, multiplier-quotient, and storage register.

ARITHMETIC UNIT

Manufacturer

	Fixed Point Incl Stor Access Microsec	Floating Point Exclud Stor Access Microsec
Add	24	84
Mult	240	24-204
Div	240	36-216

Construction (Arithmetic unit only)

Vacuum tubes and diodes

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential - internal
	Concurrent - input/output equip.

Some computing can be carried on concurrently with I/O operations.

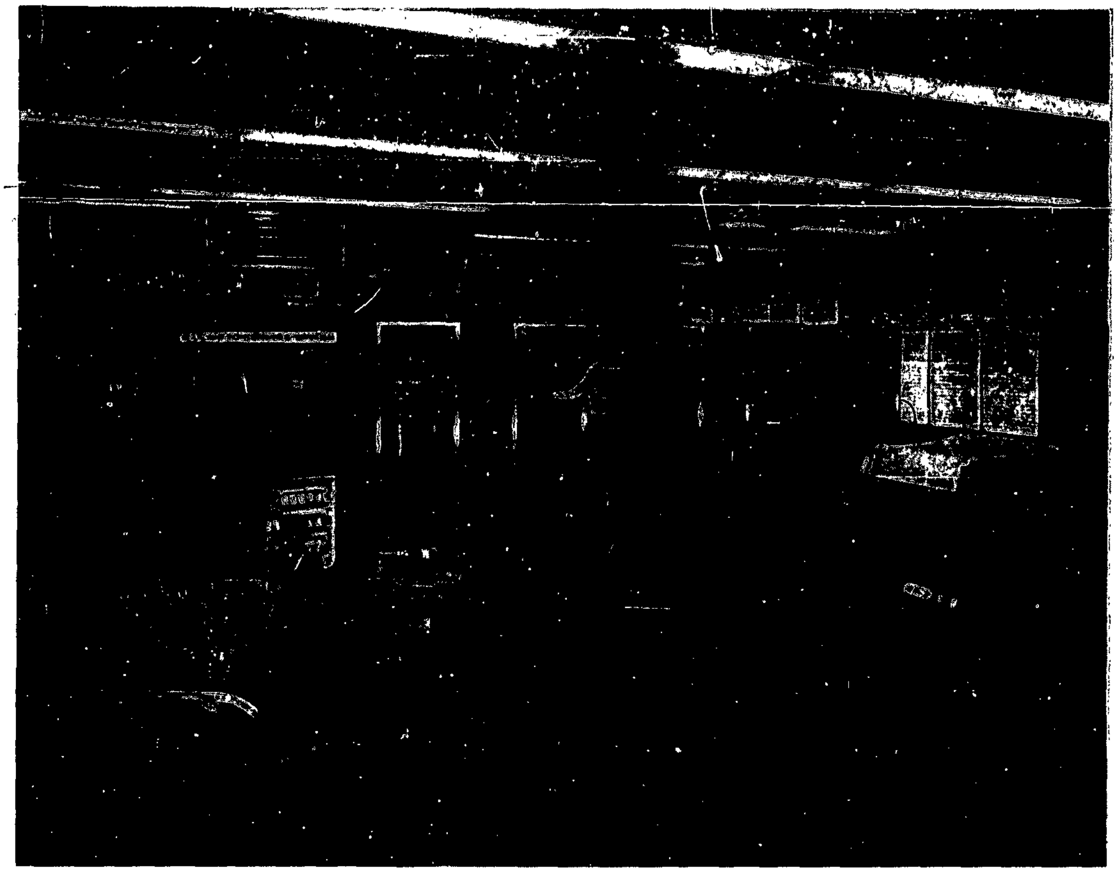


Photo by NASA Lewis Research Center

STORAGE

Manufacturer

Media	No. of Bin Words	No. of Dec. Digits Equiv.	Access Microsec
Magnetic Core	Up to 32,768	327,680	12
Magnetic Drum	Up to 16,384	163,840	12,000
Magnetic Tape	900,000	5,000,000	10,000

No. of units that can be connected	10	Units
No. of char/linear inch of tape	200	Char/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating each record	0.75	Inches
Tape speed	75	Inches/sec
Transfer rate	15,000	Char/sec
Start time	10	Millisec
Stop time	10	Millisec
Physical properties of tape		
Width	0.5	Inches
Length of reel	200-2,400	Feet
Composition	Acetate or Mylar	

Mylar is DuPont's trademark for polyester film.

If pure binary, rate is 25,000 decimal digits equivalent/sec.

USA BMA (now NASA)

Magnetic Drum 8,192 words; Magnetic Core 8,192 words; Magnetic Tape.

USA BMA (now at NASA)

Magnetic Drum 8,192 words; Magnetic Core 8,192 words; Magnetic Tape

USA WSMR CO

Magnetic Core 8,192 words; Magnetic Drum 8,192 words; Magnetic Tape

USA WSMR

MC 8,192; MD 8,192; MT

USN David Taylor

MC 32,768; MD 8,191; MT

USNOL White Oak

MC 32,768; MT Stations 8

USAF Eglin AFB

MC 32,768; MT

USAF Edwards AFB

MC 8,192; MD 8.192; MT

USAF SAC Offutt

MC 32,768; MD 8,192; MT

USAF Kirtland AFB

MC 32,768; MT

Argonne

MC 32,768; MD 8,192; MT

BFS FAA

MC 8,192; MT

NASA Ames

MC 8,192; MT

NASA Lewis

MC 8,192; MD 8,192; MT

NBS

MC 32,768; MD 8,192; MT Stations 6

NSA

MC 16,384; MT

Photo by Tennessee Valley Authority, Chattanooga

TVA
MC 16,384; MT
Allis-Chalmers
MC 8,192
AVCO
MC 32,768; MT
Bell Aero
MC 8,192; MD 8,192. (Magnetic drum on order).
Bell Tel Whippany
MC 32,768; MT
Bell Tel Murray Hill
MC 32,768; MT
Bendix Systems
MC 8,192; MD 8,192; MT Stations 7
CEIR
MC 8,192; MD 8,192; MT Stations 8
Convair Fort Worth
MC 32,768; MD 8,192; MT
Cornell Aero
MC 8,196; MD 8,196; MT
Convair San Diego
MC 32,768; MT
Douglas A-260
MC 32,768; MT 9
Douglas A-850
MC 32,768; MT 6
Douglas B-250
MC 32,768; MT 7
GE Phoenix
MC 8,192; MD 8,192; MT
GE Evendale
MC 32,768; MT 10
GE Schenectady
MC 32,768; MT
GMC Warren
MC 8,192; MD 8,192; MT
GMC Indianapolis
MC 8,192; MD 8,192; MT 8
GMC Indianapolis
MC; MD; MT
Grumman
MC 8,192; MD 8,192; MT 10
Gulf
MC 32,768; MD 8,192; MT 8
IBM PDL Poughkeepsie
MC 32,768; MD 8,192; MT 10
IBM GPD DL Endicott
MC 32,768; MD 8,192; MT
IBM San Jose
MC 32,768; MD 8,192; MT
IBM RC Yorktown Heights
MC 32,768; MT
Lockheed Marietta
MC 8,192; MD 8,192; MT 10
Marquardt
MC 8,192; MD 8,192; MT
Martin Denver
MC 8,192; MD 8,192; MT
North American
MC 8,192; MD 8,192; MT

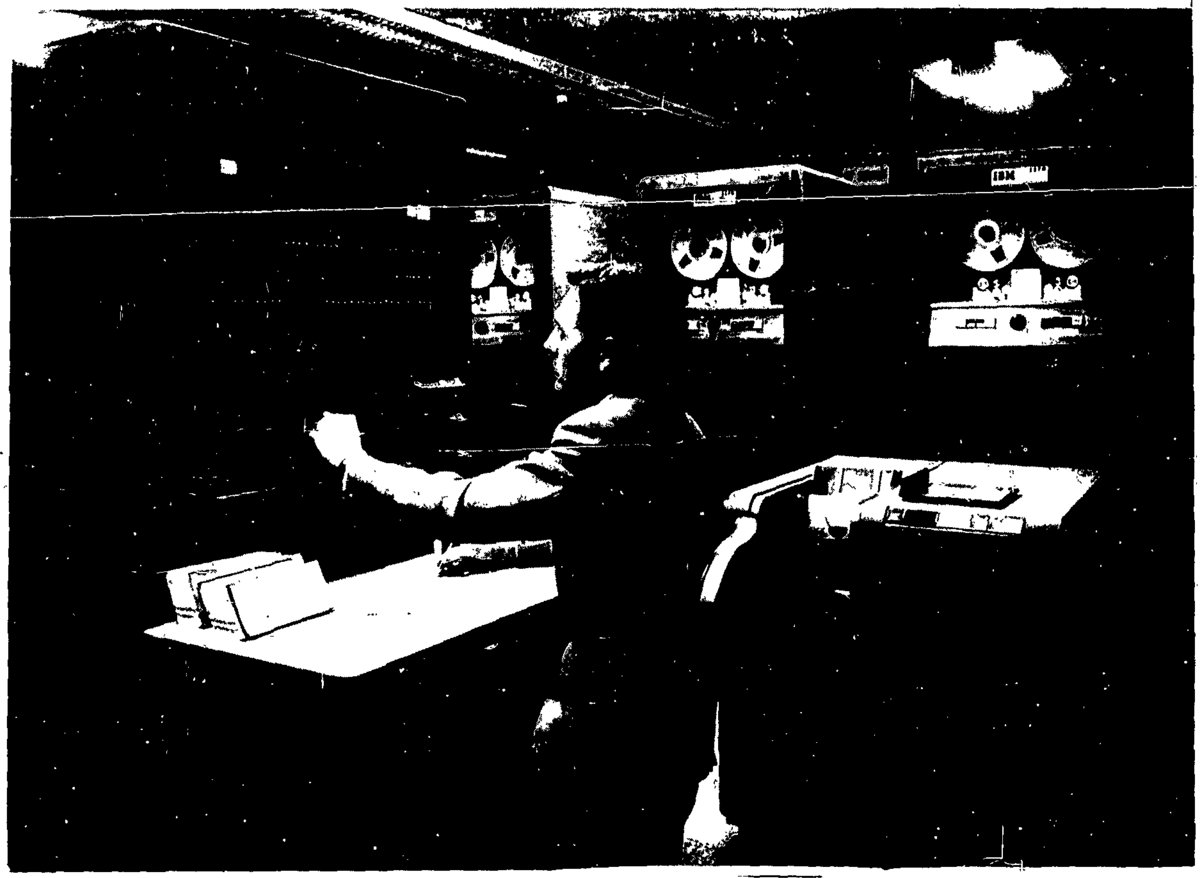


Photo by Westinghouse Electric Corporation

Pratt and Whitney
MC 32,768; MD 8,192; MT 10
Rand
MC 32,768; MD 8,192; MT 9
Raytheon
MC 4,096; MD 8,192; MT 4
Republic Aviation
MC 32,768; MT
Sandia
MC 8,192; MD 8,192; MT
Socony
MC 32,768; MT
Standard Oil California
MC 32,768; MD 8,192; MT 8
Standard Oil Indiana
MC 8,192; MD 8,192; MT
Temco
MC 8,192; MD 8,192; MT
United Aircraft (3)
MC 32,768; MD 8,192; MT 12
Chance Vought
MC 8,192; MD 8,192; MT
Westinghouse Baltimore
MC 32,768; MT 8
Westinghouse East Pittsburgh
MC 8,192; MD 8,192; MT
Cal Tech JPL
MC 32,768; MT
MURA
MC 8,192; MD 8,192; MT 4

Ohio State
MC 4,096; MD 8,192; MT
TEES
MC 4,096; MD 8,192; MT
U of Cal Los Alamos
MC 2 units 32,768 ea; 1 unit 8,192; MT
U of Cal Berkeley
MC 32,768; MT
U of Mich
MC 8,192; MD 8,192; MT 8

INPUT

Manufacturer

Media	Speed
Card Reader	150 or 250 cards/min
Magnetic Tape	
Card to Magnetic Tape	250 or 800 cards/min

The card to magnetic tape conversion is an independent operation. The higher conversion rate is using the IBM 1401 System as a conversion unit.

USAF SAC Offutt

Input media are punched cards, magnetic tape, and paper tape.

Allis Chalmers

Input medium is punched cards.

Lockheed Marietta

Input medium is magnetic tape. All other installations utilize punched cards and magnetic tape as input media.

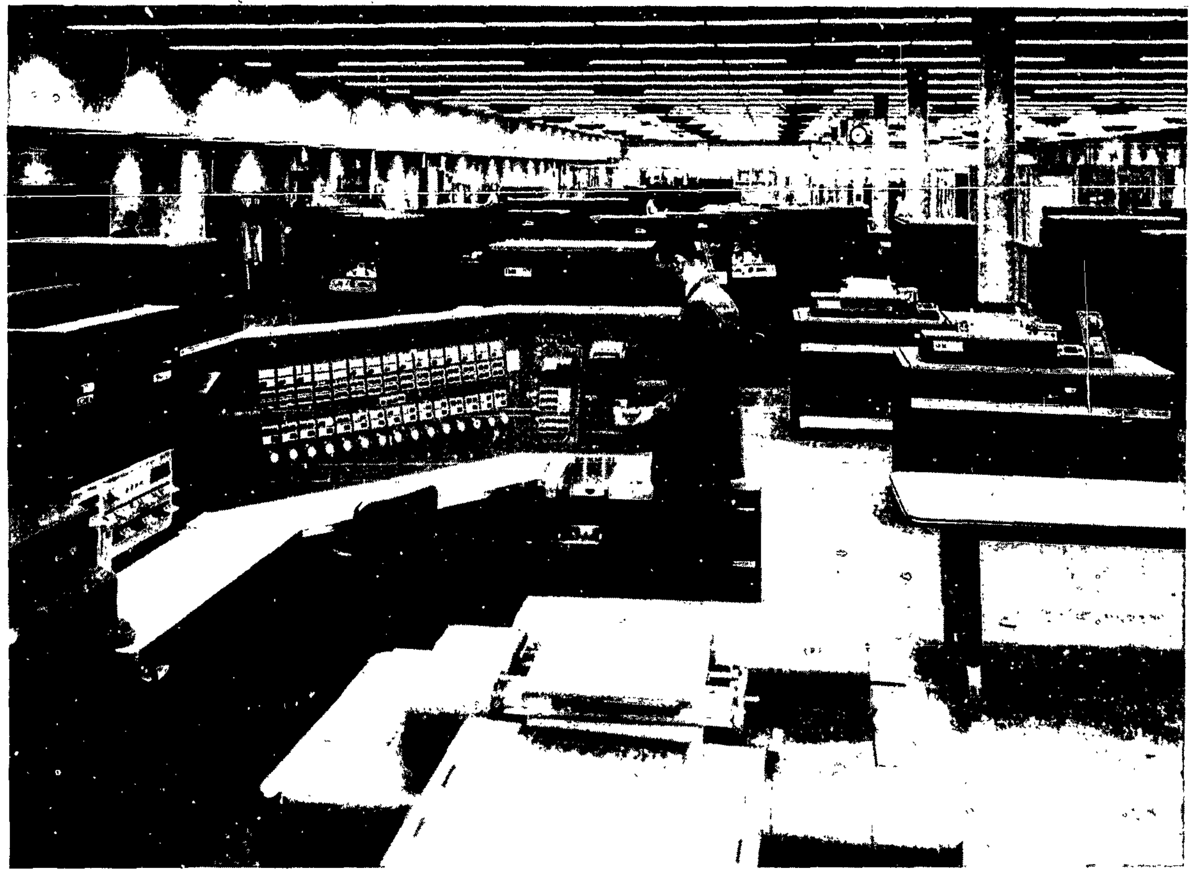


Photo by United Aircraft Corporation, East Hartford

OUTPUT

Manufacturer

Media	Speed
Card Punch	100 cards/min
Line Printer	150 lines/min
Cathode Ray Tube Display	8300 data points/sec
Magnetic Tape	
Magnetic Tape to Card	100 or 250 cards/min
Magnetic Tape to Printer	150 or 600 lines/min

Conversion is an independent operation. The higher speeds are obtained using the IBM 1401 Data Processing System off-line for tape-to-printer and tape-to-card conversion.

USNOL White Oak

Output media are punched cards, magnetic tape, printer, and cathode ray tube.

USAF Eglin AFB

Output media are punched cards and magnetic tape.

USAF SAC Offutt

Punched cards, magnetic tape, paper tape, and printer.

Allis-Chalmers

Punched cards and printer.

GE Phoenix

Punched cards and magnetic tape.

GMC Indianapolis

Punched cards and magnetic tape.

Lockheed Marietta

Magnetic tape.

Rand

Punched cards and magnetic tape.

Republic Aviation

Punched cards, magnetic tape, printer and cathode ray tube.

All other installations utilize punched cards, magnetic tape and printer as output media.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

There are 295,000, 590,000, or 1,100,000 magnetic cores, depending on memory size.

CHECKING FEATURES

Manufacturer

Magnetic Tape - horizontal and vertical parity bit check for each row and column.

Main Frame - overflow in accumulator, divide check.

Line Printer - echo checking.

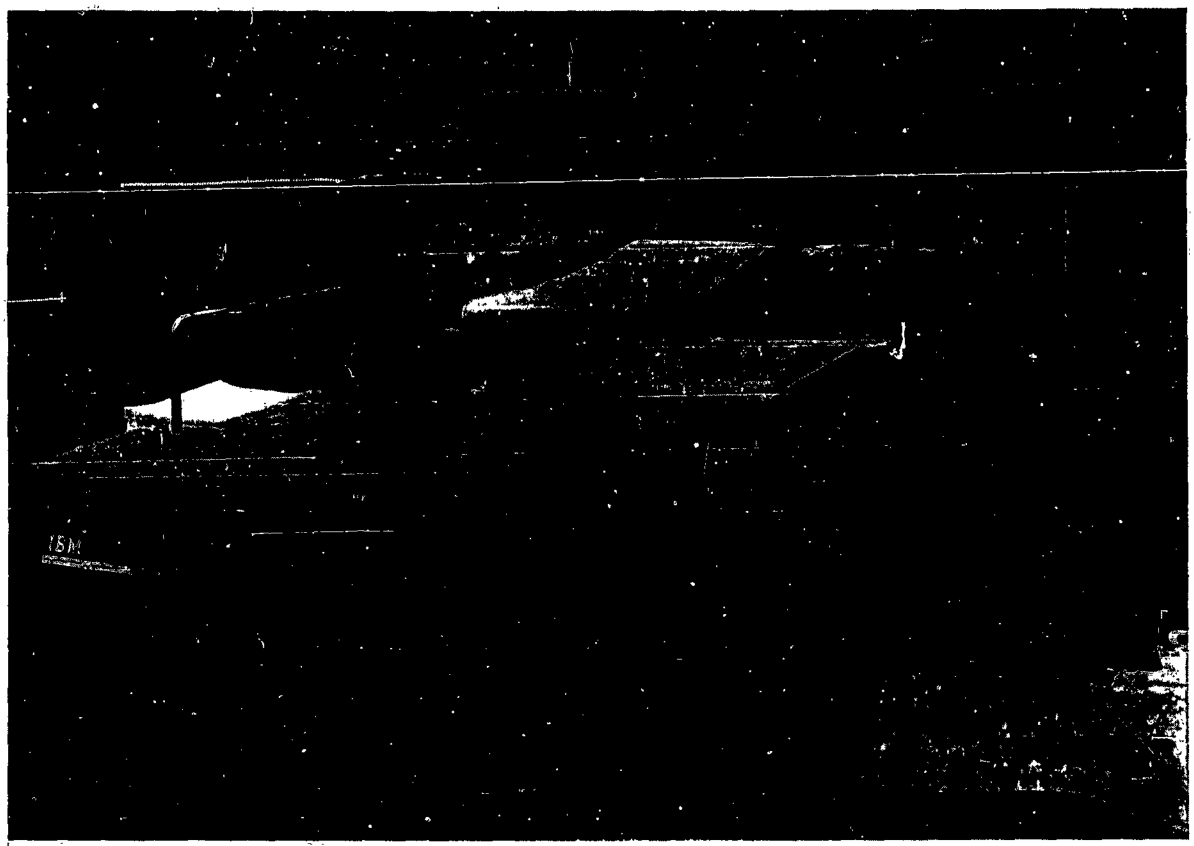


Photo by Temco Aircraft Corporation

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	84.6 KVA	0.65-0.70 pf
Capacity, air conditioner	40 Tons, approx.	
Weight, computer	19,466 lbs	

A physical planning manual is available on request.

USA BMA (Now NASA)

Power, computer	75 Kw	105.7 KVA	0.71 pf
Weight, computer		27,880 lbs	
Power, air conditioner		256,600 BTU/hr	

USA BMA (Now at NASA)

Power, computer	75 Kw	105.7 KVA	0.72 pf
Volume, computer		18,432 cu ft	
Area, computer		1,152 sq ft	
Room size, computer		1,600 sq ft	
Floor loading		24.2 lbs/sq ft	
		1,000 lbs concen max	
Weight, computer		27,880 lbs	
Capacity, air conditioner		21.4 Tons	
		256,600 BTU/hr	

Raised floor, under floor plenums, concrete block building and separate transformer bank serving main power panels.

USA WSMR CO

Power, computer	114.8 Kw	139.5 KVA	0.823 pf
Area, computer		15,000 sq ft	
Area, air conditioner		2,670 sq ft	
Capacity, air conditioner		35 Tons	
		419,790 BTU/hr	
Weight, computer		40,330 lbs	

Cinder block constructed building with tile floor, with 18 inch modified false floor for computer system, containing air conditioning plenum.

USA WSMR

Power, computer	58.73 Kw	105.7 KVA	0.56 pf
Power, air cond	67.5 Kw	90.0 KVA	0.75 pf
Volume, computer		1,039.2 cu ft	
Volume, air conditioner		3,366 cu ft	
Area, computer		197.25 sq ft	
Area, air conditioner		306 sq ft	
Room size, computer		1,628 sq ft	
Room size, air conditioner		400 sq ft	
Floor loading		16.54 lbs/sq ft	
		136.52 lbs concen max	
Capacity, air conditioner		144 Tons	
Weight, computer		26,930 lbs	
Weight, air conditioner		13,000 lbs	

False flooring for conduits, motor generator (250 KVA), and cooler (cooling tower 14 ft x 14 ft x 20 ft. plumbing - extensive and complicated). Air conditioning capacity is for total building, a portion of which is used for the computer.

USN David Taylor

Power, computer	140.0 KVA
Volume, computer	22,000 cu ft
Volume, air conditioner	16,500 cu ft
Area, computer	2,000 sq ft
Area, air conditioner	1,500 sq ft
Room size, computer	50 ft x 40 ft
Room size, air conditioner	30 ft x 20 ft
Floor loading	175 lbs/sq ft

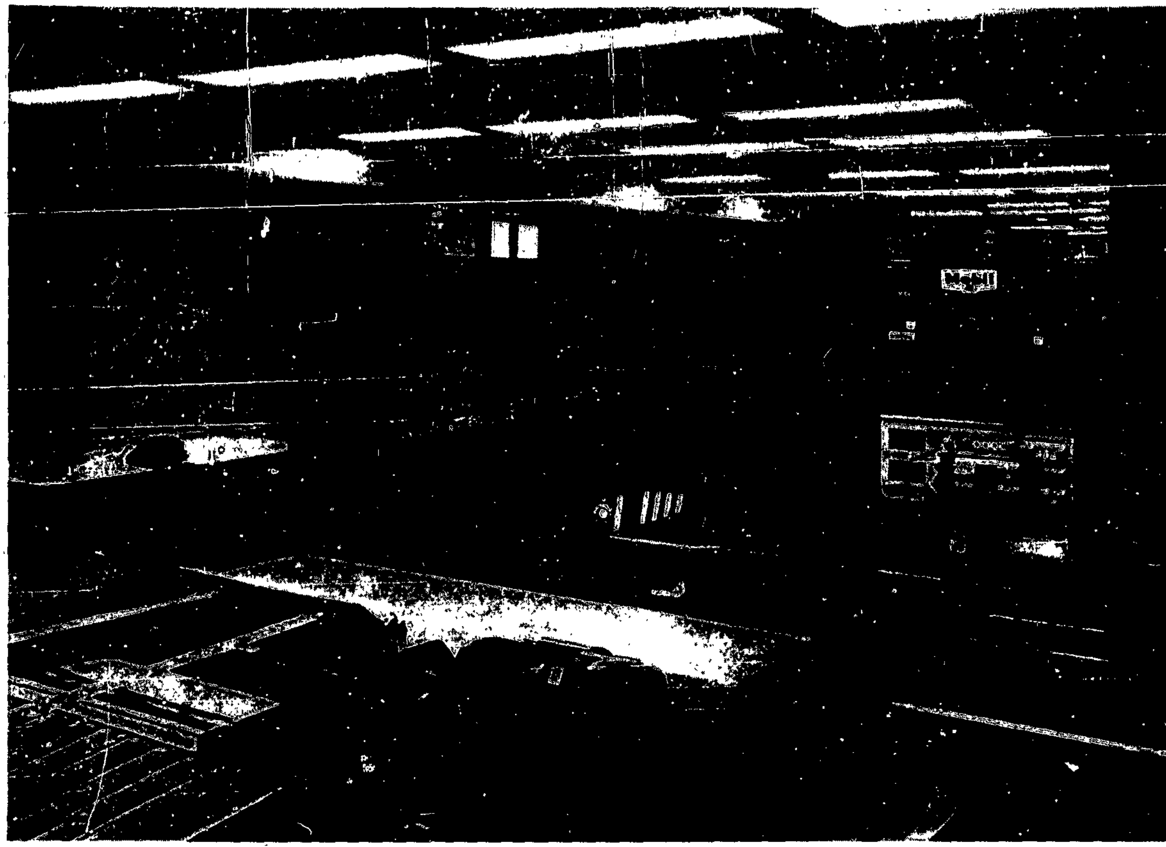


Photo by Socony Mobil Oil Company, Incorporated

Capacity, air conditioner	50 Tons		
Weight, computer	35,910 lbs		

Installation of false floor and plenums.

USNOL White Oak

Power, computer 94 Kw	138 KVA	0.68 pf	
Volume, computer	16,000 cu ft		
Volume, air conditioner	8,000 cu ft		
Area, computer	2,000 sq ft		
Area, air conditioner	1,000 sq ft		
Room size, computer	2,500 sq ft		
Room size, air conditioner	1,000 sq ft		
Floor loading	200 lbs/sq ft		
	1,000 lbs concen max		
Capacity, air conditioner	65 Tons		
Weight, computer	37,330 lbs		

False floor and ceiling which form air plenums.

USAF Eglin AFB

Power, computer & peripheral equipment	154.7 KVA	0.80 pf	
Power, air cond 8.1 Kw	12 KVA	0.80 pf	
Volume, com & per equip	19,440 cu ft		
Volume, air conditioner	10,920 cu ft		
Area, com & per equip	2,160 sq ft		
Area, air conditioner	840 sq ft		
Room size, com & per equip	45.4 ft wide		
	47.5 ft long		
Room size, air conditioner	28 ft x 30 ft		
Floor loading	100 lbs/sq ft		
	1,000 lbs concen max		
Capacity, air conditioner	75 Tons		
Weight, computer	37,770 lbs		
Weight, air conditioner	1,800 lbs		

Raised floor eight inches, put in false ceiling, permanent type, installed duct system, installed 75 ton air handling unit, and installed 75 KVA transformers 800 amp air circuit breaker and distribution panel.

USAF Edwards AFB

Power, computer	108.0 KVA		
Power, air conditioner	150 KVA	0.93 pf	
Volume, computer	1,073.6 cu ft		
Volume, air conditioner	22,000 cu ft		
Area, computer	1,683 sq ft		
Area, air conditioner	884 sq ft		
Room size, computer	61 ft x 33 ft		
Room size, air conditioner	17 ft x 37 ft		
	17 ft x 15 ft		
Floor loading	16.5 lbs/sq ft		
	27,880 lbs concen max		
Capacity, air conditioner	80 Tons		
	60 Tons available		
Weight, computer	3,150 lbs		

Air conditioning, power distribution, gutter and hangers for cabling of system, raised wooden flooring for peripheral equipment.

Photo by Republic Aviation Corporation

USAF SAC Offutt

Power, computer 98 Kw	125 KVA	0.80 pf
Floor loading	250 lbs/sq ft	
	1,000 lbs concen max	
Capacity, air conditioner	60 Tons	
Weight, air conditioner	6,000 lbs	

Power specifications for the computer air conditioning system differ under normal or emergency power operation.

During periods of normal operation, the air conditioner is tied in with the large central steam-turbine drive air conditioning system which serves the entire SAC Headquarters building. Direct application is by chilled water coil. Cooling is accomplished by a 23,000 cfm supply air fan requiring 7.5 Kw. The power facor of approximately 0.85 results in a KVA of 8.7.

The same air handling unit, producing the same chilled-water coil capacity is used under emergency power conditions. During such periods, cooling capability is supplied by two 30 ton direct expansion Worthington air conditioning units, driven by 30 hp electric motors. The same 23,000 cfm supply air fan is used. Each compressor requires 22 Kw, 26-27 KVA and has a power factor of approximately 0.85.

This computer installation is positioned in a set of rooms located in the SAC Underground Control Center. The main computer room, together with another room which houses air conditioning and other environmental control equipment are grouped so that between them they occupy a rectangular area of 50 x 59 ft. Also considered to be an integral part of the computer facility is the 12.5 x 19 x 8 ft. engineering and maintenance room, occupied by the IBM Customer Engineers.

The main computer room measures 40 x 50 ft. and has an adjoining 19 x 24.25 ft. alcove. The overall height of this room is 18 ft., which includes a subflooring space of 2.5 ft. and a false ceiling which in most areas measures 3.5 ft. The entire 18 ft. height was considered in computing the volume of this room.

Square feet	2,460.75
Cubic feet	44,293.5

The air conditioning room, 19 x 25.75 x 18 ft, has no false floor or ceiling.

Square feet	237.5
Cubic feet	1,900

It is assumed to be understood that the above figures, while reflecting adequacy for this particular computer installation, should not be construed as being typical or otherwise used as space determination criteria. Exact space specifications may vary greatly with each computer installation; their exact determination and design being a preliminary step by the potential contractor in contract negotiation.

Component parts of this computer system are interpreted as falling into the following three general categories, and the weighs given are the totals for all pieces of equipment categorized within each of

Photo by The Martin Company (Currently a 709)

these classifications:

Basic 704	30,720 lbs
Additional 704	13,070 lbs
PCAM	9,764 lbs
	53,554 lbs

Design, engineering and construction specifications related to site preparation for this computer installation are considered unique in that the SAC Underground Control Center was in being at the time computer installation site construction was accomplished. This involved finishing out an underground are directly under the then-existing engine generator room of the SAC Control Center. This finishing out project included not only the rooms described above, but additional areas which were designed to serve as a supporting office area and conference room. Work specifications necessary to develop this area into suitable configuration for establishment of a computer system therein was accomplished in accordance with the criteria contained in the Physical Planning Installations Manual 701, 704 and 709 Data Processing Systems, dated 15 December 1957, published by the Sales Engineering Department of the International Business Machines Corporation. This manual contains a significant amount of detailed technical information pertinent to installation of the specified computers in any given area.

Machine	Basic System Name	Weight in Lbs.
704	Central Processing Unit	3,150
711	Punched Card Reader	560
716	Alphabetic Printer	1,910
721	Punched Card Recorder	670
727 (10)	Magnetic Tape Unit	950 ea
733	Magnetic Drum Unit	1,930
736	Power Frame No. 1	2,400
738	Magnetic Core Storage Unit	4,000
741	Power Frame No. 2	3,250
746	Power Distribution Unit	1,110
753	Tape Control Unit	2,240
		30,720
	Additional Equipment	
714	Card Reader	1,150
720	Printer	1,600
727 (2)	Magnetic Tape Unit	950 ea
747	TDS Power Supply	2,000
759	Card Reader Control Unit	2,160
760	Control & Storage Unit (720)	760
774	Tape Data Delector	2,300
		11,870

The 9307 Tape Punch Reader and its supporting power supply weigh 500 and 700 lbs respectively. These two items are classified as additional equipment. The total weight would come to 13,070 lbs.

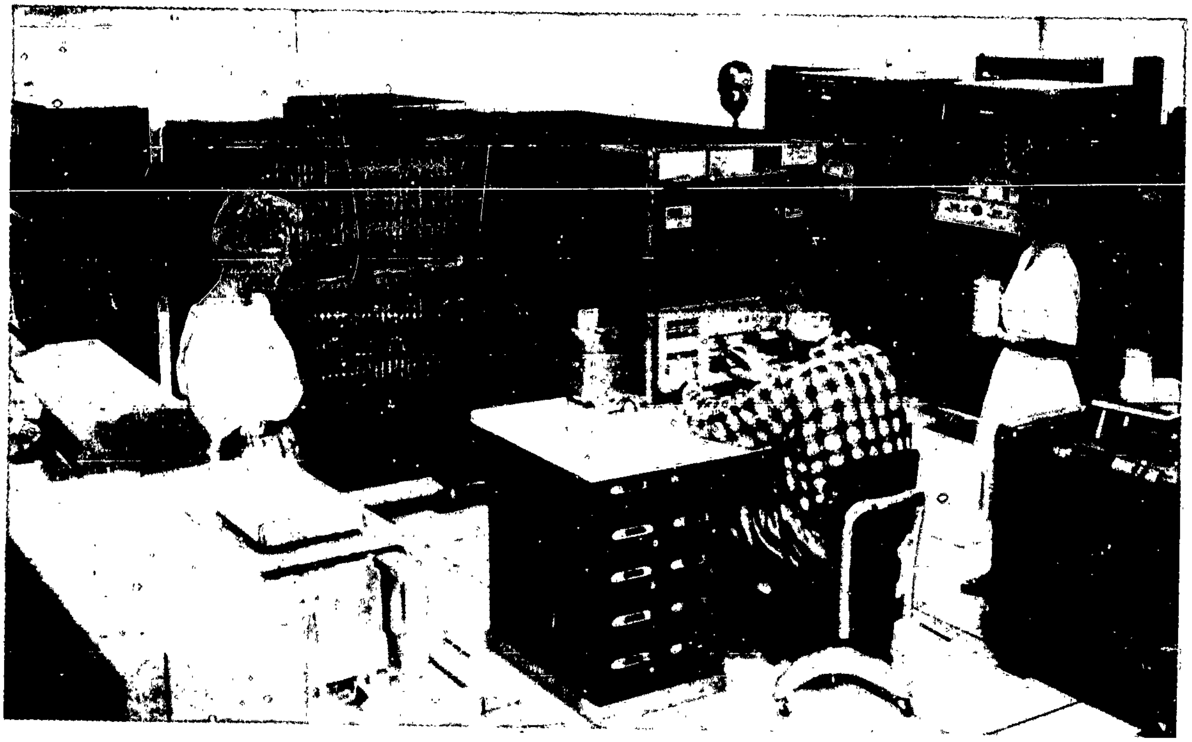


Photo by Grumman Aircraft Engineering Corporation

PCAM Components

Machine	Name	Weight in Lbs
010	Binary Punch	29
026(5)	Printing	222 ea
026(2)	Printing Card Punch	222 ea
047	Tape Controlled Card Punch	307
056(2)	Card Verifier	222 ea
056	Card Verifier	222
063	Card Controlled Tape Punch	314
083	Card Sorter	500
089	Alphabetic Collator	1,027
407	Accounting Machine	3,826
519	Document Originating Machine	1,311
552	Card Interpreter	770
		9,764

Grand Total, all equipment: 53,554 lbs.

USAF Kirtland AFB

Power, computer	83.12 Kw	103.9 KVA	0.80 pf
Power, air cond	30.0 Kw	39.5 KVA	0.76 pf
Volume, computer		982.4 cu ft	
Volume, air conditioner		850.0 cu ft	
Area, computer		207.6 sq ft	
Area, air conditioner		156.0 sq ft	
Room size, computer		185.0 sq ft	
Room size, air conditioner		282.0 sq ft	
Floor loading		750 lbs/sq ft	
		750 lbs concen max	
Capacity, air conditioner		26 Tons	
Weight, computer		24,810 lbs	

Building was in existence as an instrument shop. Site modification included installation of a raised floor to provide air conditioning plenum, and electrical wiring. False floor was in existence. Building is a block wall. Air conditioning. Pressurization prevents dust from entering.

BFS FAA

Power, computer	117.7 KVA
Volume, computer	17,280 cu ft
Area, computer	1,728 sq ft
Room size, computer	72 x 24 x 10 ft
Floor loading	100 lbs/sq ft
	1,000 lbs concen max
Capacity, air conditioner	50 Tons
Weight, computer	28,750 lbs

Air conditioning is supplied from a central air conditioning unit that furnishes cooling for a complete building. Site prepared in a new brick structure. There are false ceilings, free access type floor, concrete block construction for the interior. There are no windows. The free access floor has 3 ft x 3 ft square flooring supported by a raised metal framework. There is complete interchangeability of the square flooring panels.

NASA Ames

Power, computer	45.6 Kw	100.6 KVA	0.80 pf
Power, air conditioner		45.6 Kw	
Volume, computer		3,330 cu ft	
Volume, air conditioner		264 cu ft	
Area, computer		666 sq ft	
Area, air conditioner		32 sq ft	
Room size, computer		47 x 35 ft	
Floor loading		100 lbs/sq ft	
		1,000 lbs concen max	
Capacity, air conditioner		37.5 Tons	
Weight, computer		23,100 lbs	
Weight, air conditioner		4,000 lbs	

The 704 was placed in a converted shop in a wind tunnel building. No false ceiling was installed but a false floor was built to accommodate cabling and serve as a plenum for under floor coating. One floor air conditioner was installed and three over head units. The power for the computer was taken off

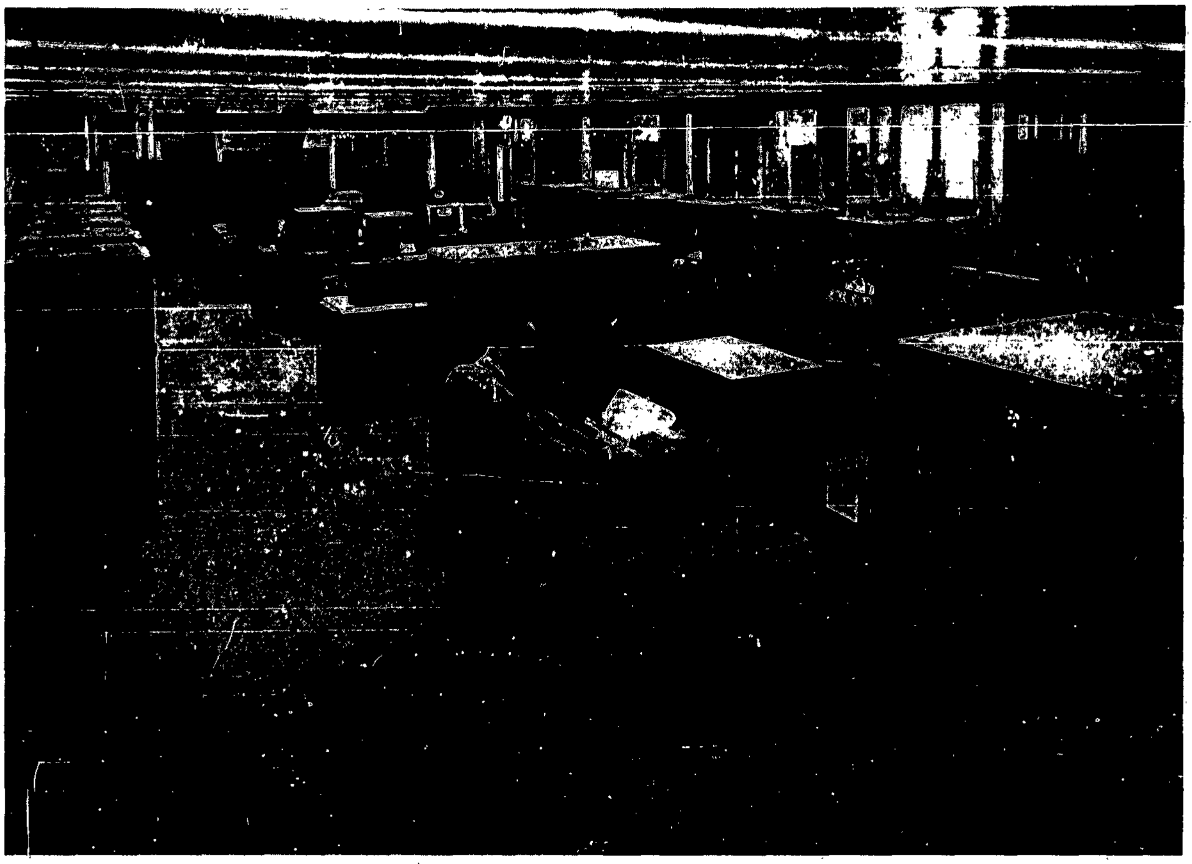


Photo by General Motors, Detroit

before the building cut-off and has no other loads on it except the computer and the air conditioner.

NASA Lewis

Power, computer	135.1 KVA	
Power, air conditioner	37.3 KVA	
Volume, computer	22,680 cu ft	
Volume, air conditioner	4,000 cu ft	
Area, computer	2,268 sq ft	
Area, air conditioner	400 sq ft	
Room size, computer	54 x 42 ft	
Room size, air conditioner	20 x 20 ft	
Floor loading	100 lbs/sq ft	
Capacity, air conditioner	50 Tons	

Raised floor used as plenum chamber and cable space. Separate power feeder; auxiliary ducts in ceiling. Partitions. Insulated water lines from basement to 3rd floor. Concrete pad for water chillers. Existing building construction was reinforced concrete.

NBS

Power, computer	131 KVA	0.70 pf
Power, air conditioner	45 KVA	
Volume, computer	16,000 cu ft	
Volume, air conditioner	4,000 cu ft	
Area, computer	1,600 sq ft	
Area, air conditioner	400 sq ft	
Room size, computer	40 x 40 ft	
Room size, air conditioner	20 x 20 ft	
Floor loading	20 lbs/sq ft	
	120 lbs concen max	
Capacity, air conditioner	40 Tons	
Weight, computer	32,110 lbs	
Weight, air conditioner	5,000 lbs	

False floors - Quonset Hut.

TVA

Power, computer		100 KVA	
Power, air cond	72 Kw(1)	166 KVA(2)	0.90 pf
Volume, computer		1,700 cu ft	
Volume, air conditioner		13,100 cu ft	
Area, computer		258 sq ft	
Area, air conditioner		1,456 sq ft	
Room size, computer		2,450 sq ft	
		11 ft. ceiling	
Room size, air conditioner		1,456 sq ft	
Floor loading		200 lbs/sq ft	
		6,000 lbs concen max	
Capacity, air conditioner		110 Tons (2 55 ton systems)	
Weight, computer		42,210 lbs	
Weight, air conditioner		9,200 lbs (does not include duct, piping, insulation & fittings)	

The system was installed in an old building of structural steel and masonry construction. A portion of the building was remodelled with raised removable floor, dropped fireproof acoustical ceiling, panel and acoustical sides, recessed lighting, separate duplicate air-conditioning systems, new 2,000A 4-wire electrical entrance and distribution system, all meeting or exceeding IBM specifications.

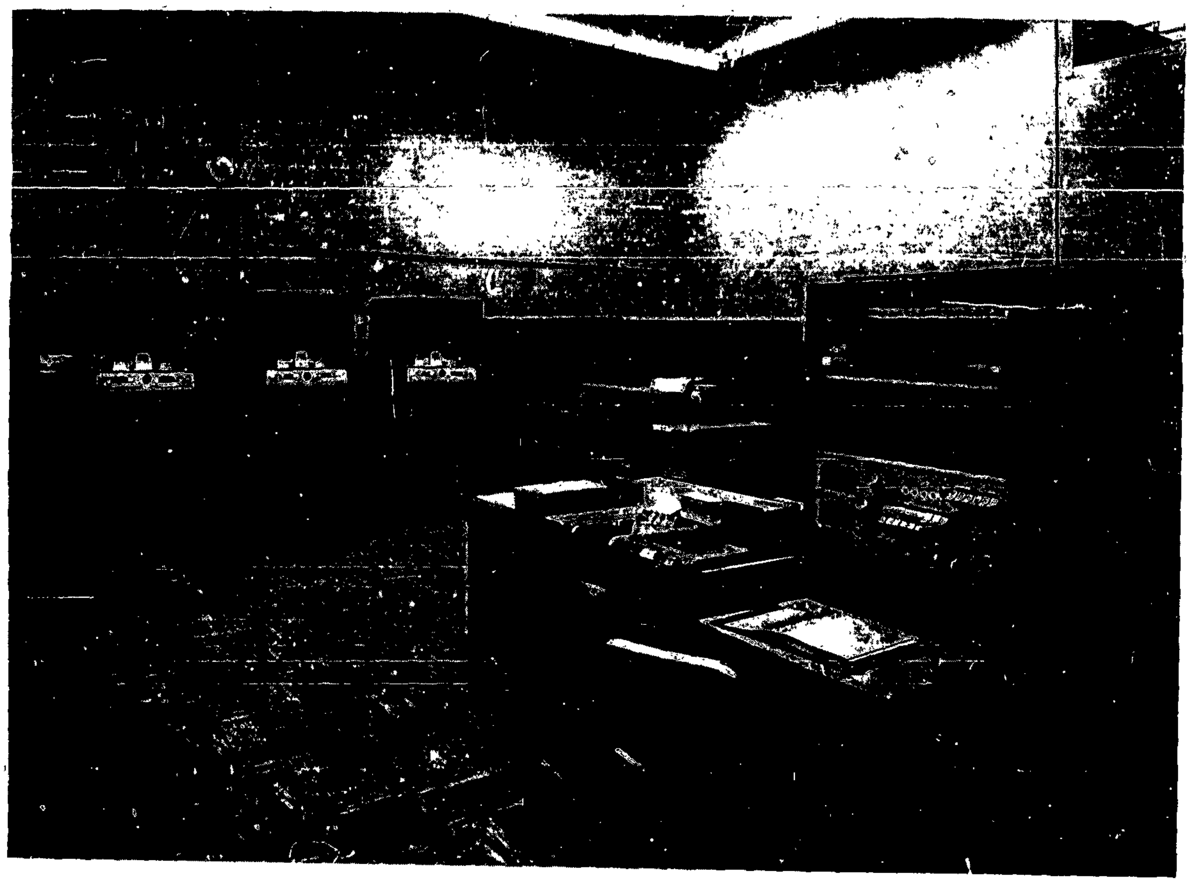


Photo by General Motors, Indianapolis

Allis-Chalmers

Power, computer	75 KVA	0.85 pf
Power, air conditioner	25 Kw	
Area, computer	2,000 sq ft	
Area, air conditioner	200 sq ft	
Capacity, air conditioner	25 Tons	
Weight, air conditioner	5,000 lbs	

False ceilings, trenches dug in ground floor.

AVCO

Volume, computer	25,000 cu ft
Area, computer	2,500 sq ft
Room size, computer	50 x 50 ft

Area was prepared under manufacturer supervision during laboratory construction.

Bell Aero

New building to meet IBM requirements.

Bell Tel Whippany

Power, computer		160 KVA	
Power, air cond	90 Kw	100 KVA	0.90
Volume, computer		28,000 cu ft	
Volume, air conditioner		5,760 cu ft	
Area, computer		3,500 sq ft	
Area, air conditioner		720 sq ft	
Room size, computer		28 ft x 124 ft	
Room size, air conditioner		20 ft x 36 ft	
Floorloading		275 lbs/sq ft	
		1,000 lbs concen max	
Capacity, air conditioner		100 Tons	
Weight, computer		46,970 lbs	
Weight, air conditioner		41,000 lbs	

Computer located in basement of new building, concrete, steel, block and stucco. Plenum type floor, free access type raised floor. False ceilings. Power distribution - 120/208 volts. 300 KVA transformer.

Bell Tel Murray Hill

Power, computer	110 KVA
Area, computer	1,000 sq ft
Area, air conditioner	300 sq ft
Room size, computer	2,700 sq ft
Room size, air conditioner	400 sq ft
Capacity, air conditioner	80 Tons
Weight, computer	27,000 lbs
Weight, air conditioner	20,000 lbs

False floating floor. To minimize cool air duct work and facilitate inter machine cable connections. False ceiling.

Bendix Systems

Power, computer	112 Kw	140 KVA	0.80 pf
Power, air cond	48 Kw	60 KVA	0.80 pf
Volume, computer		32,000 cu ft	
Volume, air conditioner		1,000 cu ft	
Area, computer		3,200 sq ft	
Area, air conditioner		100 sq ft	
Room size, computer		3,200 sq ft used	
Capacity, air conditioner		60 Tons	
Weight, computer		31,350 lbs	
Weight, air conditioner		10,000 lbs	

The installation which houses the computing facility was built so that a minimum of changes and/or modifi-

Photo by General Motors, Warren

cations would be necessary for any equipment that might be installed. The cabling is laid in concrete troughs under the floor on a 7 ft. grid. These channels are covered with removable flooring. Input power and cable connections to auxiliary equipment are accommodated under the floor.

CEIR

Power, computer	75.0 Kw	106.8 KVA	0.70 pf
Power, air cond	10 Kw	12 KVA	0.85 pf
Volume, computer		9,000 cu ft	
Volume, air conditioner		10,000 cu ft	
Area, computer		900 sq ft	
Area, air conditioner		1,000 sq ft	
Room size, computer		25 ft x 40 ft	
Room size, air conditioner		25 ft x 40 ft	
Floor loading		30 lbs/sq ft	
		125 lbs concen max	
Capacity, air conditioner		120 Tons	
Weight, computer		27,886 lbs	
Weight, air conditioner		27,000 lbs	

Air conditioning handles two computers (704 and 709). Brick and mortar built-up floor over concrete slab with channels 6 inch deep for cables. False ceiling.

Convair Fort Worth

Power, computer	131.1 Kw	164.7 KVA	0.80 pf
Volume, computer		31,140 cu ft	
Area, computer		3,114 sq ft	
Room size, computer		43.5 ft x 29 ft	
		32.5 ft x 57 ft	
Floor loading		14.6 lbs/sq ft	
Floor loading		1,000 lbs concen max	
Weight, computer		45,420 lbs	

Equipment was installed in an existing reinforced concrete building. A false floor provides an underfloor plenum for inlet of conditioned air. A false ceiling provides a return air plenum. Wooden partition walls were built to enclose the equipment area. Power distribution is to two points for the 704 and three points for peripheral equipment. The power is supplied as regulated 208V 3 phase from a voltage reduction transformer bank.

Cornell Aero

Power, computer	75.6 Kw	101.3 KVA	0.745 avg. pf
Power, air cond	51 Kw	60 KVA	0.85 pf
Volume, computer		24,000 cu ft	
Volume, air conditioner		3,880 cu ft	
Area, computer		3,000 sq ft	
Area, air conditioner		388 sq ft	
Room size, computer		65 x 49 ft	
Room size, air conditioner		16 x 18 ft & 10 x 10 ft	
Floor loading		200 lbs/sq ft	
		800 lbs concen max	
Capacity, air conditioner		35 Tons	
Weight, computer		30,400 lbs	
Weight, air conditioner		11,000 lbs	

Power, computer - 208v, 3 phase, 2 No. 4/0 AVB per phase, 416 amp.

Power, air conditioner - 440v, 3 phase, 1 No. 2/0 RH per phase, 175 amp.

Raised sectional floor and suspended acoustical ceiling in existing building.

Photo by Bendix Systems Division, Bendix Corporation, Ann Arbor

Convair San Diego

Concrete building, plenum, 100 Ton air conditioning, 220 volt, 3 phase, 600 amp main frame, 100 amp each for both printers, one punch and one reader.

Douglas A-260

Power, computer	125 KVA
Area, computer	2,000 sq ft
Area, air conditioner	1,300 sq ft
Room size, computer	40 x 50 ft
Floor loading	16 lbs/sq ft 200 lbs concen max
Capacity, air conditioner	50 Tons
Weight, computer	23,000 lbs

Sealed area, six inch raised false floor installed over power cables, a/c unit and air filter installed, motor generator set with transformer and controls.

Douglas A-850 (2)

Power, computer	125 KVA
Area, computer	2,000 sq ft
Area, air conditioner	1,200 sq ft
Room size, computer	40 x 50 ft
Floor loading	16 lbs/sq ft 200 lbs concen max
Capacity, air conditioner	40 Tons
Weight, computer	24,000 lbs

Sealed area; a/c ducts installed with 500 RCE/sink for each component, a/c unit and air filter installed, motor generator set with transformer and controls. Requirements are for each system.

GE Phoenix

Power, computer	83.2 Kw	112.2 KVA	0.74 pf
Volume, computer		180,000 cu ft	
Area, computer		2,899 sq ft	
Floor loading		8.48 lbs/sq ft	
Weight, computer		24,610 lbs	

False floor.

GE Evendale

Power, computer	63.54 Kw	114.8 KVA
Volume, computer		8,800 cu ft
Area, computer		880 sq ft
Weight, computer		28,610 lbs

The building was designed expressly for housing large-scale digital computers. It was completed in 1955. The flooring in the machine room area is wood to allow cable holes to be made easily. Crossed braced supporting girders permit cables to be strung through them, thus minimizing cable lengths. False ceilings are used in the floor below machine rooms.

GE Schenectady

Power, computer	126.4 KVA
Area, computer	1,775 sq ft
Capacity, air conditioner	100 Tons
Weight, computer	32,760 lbs

False ceilings, trench floor.

GMC Warren

Power, computer	162.6 KVA	0.75 pf
Power, air conditioner	50 Kw	0.90 pf
Volume, computer	25,088 cu ft	
Volume, air conditioner	1,200 cu ft	
Area, computer	2,688 sq ft	
Area, air conditioner	360 sq ft	
Room size, computer	32 x 84 ft	
Room size, air conditioner	12 x 30 ft	
Floor loading	100 lbs/sq ft 1,000 lbs concen max	
Capacity, air conditioner	70 Tons	
Weight, computer	40,140 lbs	

All air handling is done above a false ceiling with high heat-load machines individually exhausted. Primary power for the 704 is obtained from a transformer installed particularly for it. The main 704 power is interlocked with the automatically controlled air conditioning system.

GMC Indianapolis

704 System set on concrete floor - use portion of central air conditioning system. Additional a/c ducts installed. Provide power for operation of computer.

GMC Indianapolis

A two foot plenum chamber was constructed to be used for electrical and power supply cables as well as for supplying cooled air into the base of certain units. A vinyl plastic non-static floor was installed over the complete area and either cemented to the concrete floors on grade or to the surface of removable floor panels in the computer room. A honeycomb type of aluminum ceiling was installed at a height of approximately 10 feet over the entire area with lighting, air conditioning and duct work installed above this ceiling. Conditioned air was also supplied from above this ceiling to blend with the air supplied from below the floor.

Grumman

Removable floor panels; air conditioning intakes and release plenums extended thru roof; provided separate 500 KVA transformer for computer only; air

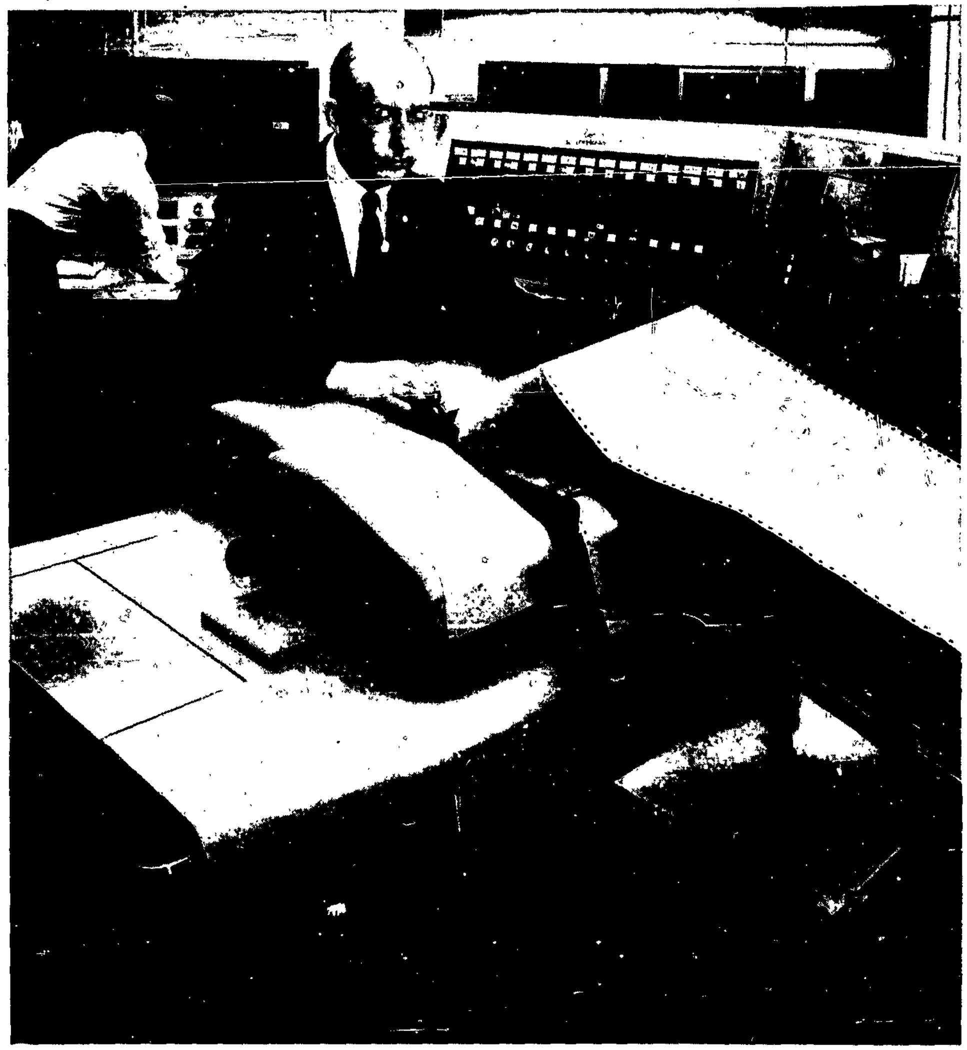


Photo by Bell Telephone Laboratories

conditioner powered from a separate source; and installed lighting for 30 foot-candles.

Gulf

New wing (2-story) added to existing building to house computer and programming and operating staff. Underfloor plenum and overhead air conditioning return in machine room. Air conditioner serves offices also.

IBM PDL Poughkeepsie

Reinforced concrete building; pedestal panel type raised floor, suspended acoustical ceiling with plenum above; double glazing of exterior windows; and vapor barrier control.

IBM GPD DL Endicott

False floor (removable sections), separate transformer (138 v AC 3 phase), false ceiling (removable sections).

IBM RC Yorktown Heights

Floating false floor and air conditioner required.

Marquardt

Existing computer area in engineering office building was enlarged and modified. Building is one story, of concrete tilt-up construction. Modifications include: trenched floor for cables; dropped, integrated ceiling for return air plenum; 2-step lighting; acoustic tile down to wainscoat.

Martin Denver

False ceiling, under floor ducts, raise floor placed in new office building and original area designed for computer installation. Power distribution system was provided separate from building system.

North American

Raised floors and acoustic ceiling and walls.

Pratt and Whitney

This machine is located in an air conditioned space. The space has a raised wooden floor with asphalt tile flooring. Conditioned air is supplied to the space by means of ductwork and ceiling diffusers with the space above the false ceiling serving as a return air plenum. Basic building construction is reinforced concrete with Hauserman metal inner partitions.

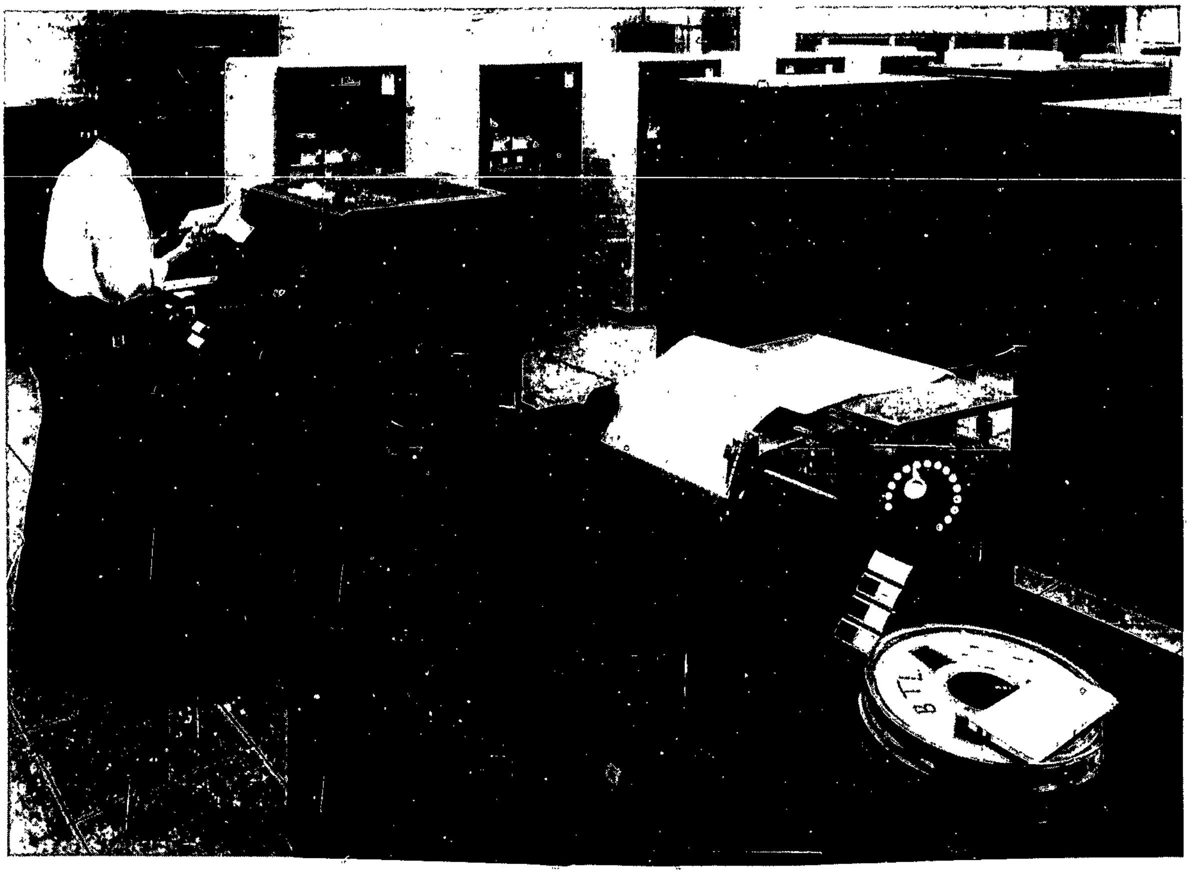


Photo by Bell Telephone Laboratories

Sandia

Air chamber in floor for cooling equipment, air plenum above false ceiling for return air. Connecting cables in conduit under floor.

Socony

A 12 inch raised floor was installed for cable passage and which also acts as a plenum. There were no major building modifications other than the relocation of office space. Power supply to the computer is through a 500 KVA transformer installed in a room adjacent to the Computer Center.

Standard Oil California

Raised false floor, partitioning, lighting, independent power supply and independent air conditioning.

Standard Oil Indiana

Additional air conditioning installed in existing false ceiling. Raised wooden floor installed with specific cable channels required.

Temco

Concrete floor dropped 18 inches below main floor during building construction, for cabling and air-conditioning plenum beneath machines in 48 ft x 48 ft area. 1 1/2 inch plywood panels (2 x 4 feet) with strip vinyl covering installed on 4 ft x 4 ft beams and joists. Air filtered electronically from main building system before entering computing area - humidity and temperature controlled. Electrical power obtained from separate sub-station.

United Aircraft (3)

Computer room - cinder block walls, concrete slab with raised wood and tile floor 80 ft x 200 ft to provide wire way. Concrete roof (supporting fan room) with acoustic false ceiling which provides exhaust plenum. Power distribution - six (200 KVA each) 3 phase, 208 volt distribution panels.

Chance Vought

Raised wood platform with race ways for cabling. Air-conditioning for room only.

Westinghouse Baltimore

A special 34 x 46 foot computer room was constructed with trenches and channels formed in the concrete floor and a metal pan false ceiling. The trenches and channels are used for concealed electrical cable raceways and distribution of underfloor air conditioning of fixed temperature and humidity to those units generating a high heat load. Environmental control of the total air conditioning is maintained by air diffused throughout the room by means of the plenum chamber formed by the false ceiling and the structural ceiling. Electrical power for the computer and peripheral equipment is supplied by a 10 KVA transformer completely separate from the main building service, through a 400 amp distribution panel.

Cal Tech JPL

Special room constructed consisting of raised floor 16 inches high on adjustable jacks. Also false ceiling with tight air plenum above. All wiring and cable connections under floor.

Photo by Cornell Aeronautical Laboratory, Incorporated

MURA
Installation of vapor-proofed walls and ceiling. Installation of false floor (raised) with free access for ducts and cables.

TEES
The building is a new (1959) building constructed just to house the data processing equipment. It has all the air conditioning and power necessary to handle any known computer. The building has 12,000 square feet of floor space.

U of Cal Berkeley
False ceiling and false floor.

U of Mich

Air conditioning		40 Tons
Floor space	Machine room	3,300 sq ft
	Office	1,600 sq ft

PRODUCTION RECORD

Manufacturer
No delivery schedule in effect; availability basis only.

COST, PRICE AND RENTAL RATES

		Model	Monthly Charge	Purchase Price
704	CPU w/Flo Pt	1	$9,700	$523,800
736	Power Frame No. 1	2	1,100	57,200
741	Power Frame No. 2	2	1,400	72,800
746	Power Distrobution Unit	2	1,300	67,600
711	Punched Card Reader	2	800	52,000
716	Printer	1	1,200	78,050
721	Card Punch	1	600	39,000
727	Magnetic Tape Unit	1	550	29,800
753	Tape Control Unit	1	2,500	140,250
733	Magnetic Drum Unit (8,192 words)	1	3,100	167,400
737	Mag Core Stor (4,096)	1	4,000	208,000
738	Mag Core Stor (32,768)	1	20,000	1,040,000
740	CRT Output Recorder	1	2,700	162,000
780	Display Unit	1	150	8,700
714	Card Reader	1	1,500	97,500
759	Card Reader	1	900	54,000
717	Printer	1	1,200	73,950
757	Printer Control Unit	1	600	36,000
722	Card Punch	1	750	44,400
758	Card Punch Control Unit	1	300	18,000
720	Printer (500 lpm)	1	1,400	74,200
760	Printer Cntrl & Storage	1	1,850	111,000

The base purchase price is used in computing the discounted purchase price based on the age of the

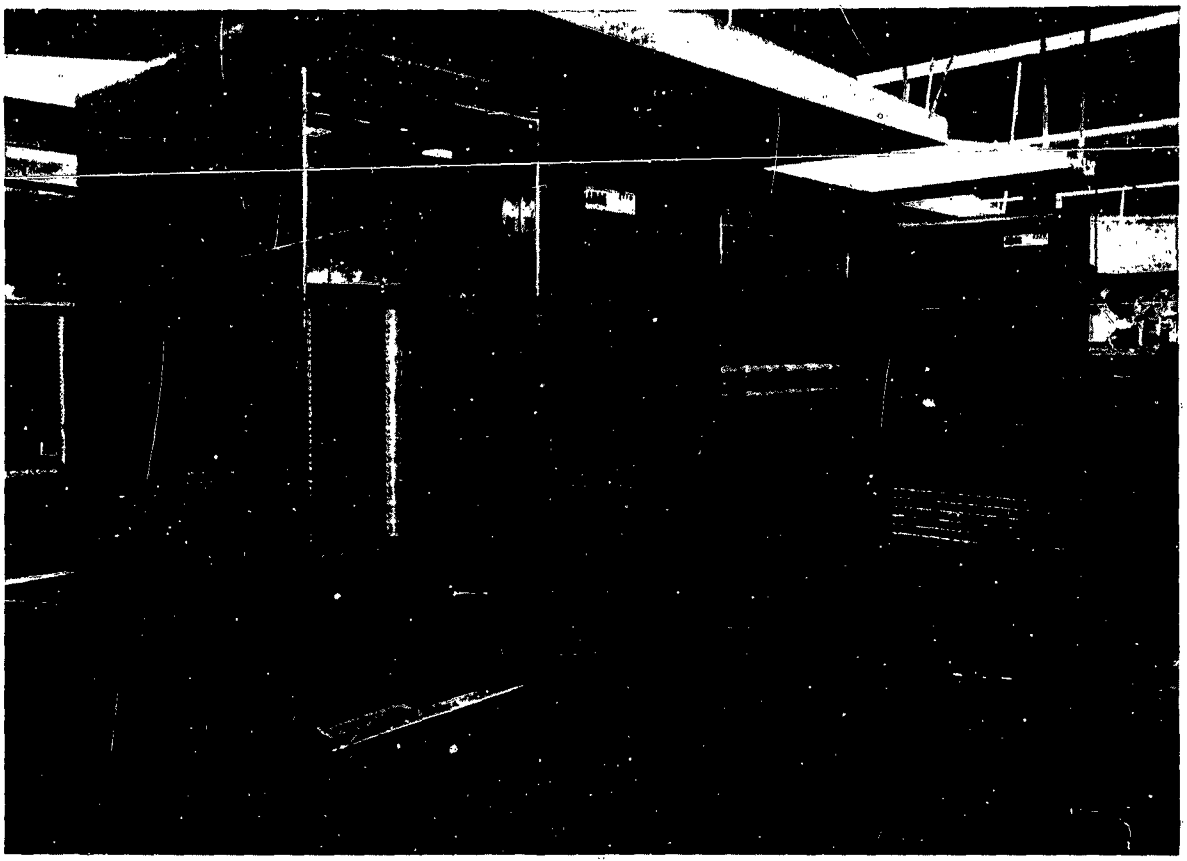


Photo by University of California LRL

installed machine. A published discount schdule is available from IBM.
Monthly rental, typical system: $44,000 and up
Purchase price, typical system: $1,994,000 and up
Maintenance contract available.

USA BMA (now NASA) (2)
704, 711, 716, 721, 8-727's, 733, 736, 2-737's, 741, 746, 753 - $33,270 per month.

USA WSMR CO
Basic System
704, 711, 716, 721, 727 (13), 733, 737 (2), 736, 741, 746, 753, 759, 760, 714, 720, 010 (4), 026 (4), 056 (2), 082, 407, 514, 557. Total approx. rental $49,500 per month.
Additional Equipment
$19,700 per month.

USA WSMR
Basic System
IBM 704, 7-727, 711, 716, 721, 753, 733, 2-737, 736, 741, 746: $33,380 per month.
Additional Equipment
IBM 2-519, 747, 774, 2-407, 759, 714, 727, 077, 089, 552, 082, 056, 2-026, 4-024: $12,682 per month.

USN David Taylor
CPU, 10 tape units, core storage, and drum storage rents at $50,000/month, one shift rental.

USNOL White Oak

Basic System	Cost	Monthly Rental
IBM 704 EDPM	$2,071,600	$45,500

Additional Equipment	Cost	Monthly Rental
IBM Type 717 Tape Printer	$118,200	$2,600
IBM Type 714 Card-to-tape Converter	96,650	2,950

USAF Eglin AFB
704 Computer and peripheral equipment 2,255.5 hrs on a three shift operation including overtime -$89,856.52 per month.

USAF Edwards AFB
704, 711, 716, 721, 8-727's, 733, 2-737's, 741, 746, and 753 rents at $33,365/month.
714, 2-727's, 747, 759, and 774 rents at $6,515/mo.

USAF SAC Offutt
All series 700 IBM equipment, whether classed as basic or additional, is retained on a rental basis under the terms of contract No. GS-00S-23293, Machine Service for the US Government, which was negotiated between IBM, the contractor and the Federal Supply Branch of the General Services Administration. Basically this contract permits us to use all series 700 equipment for 176 hours per month (prime shift) at basic rental rates. Extra shift rental is computed at approximately 40% of the basic rate. Currently we are utilizing this equipment on a three shift per day basis. Due to the numerous combinations of computer equipment which may be effected to comprise any one separate computer system or installation, it is largely a matter of personal interpretation as to which components constitute basic or additional terms.

The lists of components, which itemize individual basic rental rates, were compiled in this light.

All PCAM equipment is retained on a rental basis under the terms of contract No. GS-00S-22633, which bears the same title and is between the same principals cited in the preceding paragraph. Currently, this equipment is retained on a one shift rental basis.

The total monthly rental rate for prime shift utilization of all rental components is $59,513.

The IBM 9307 Tape (paper) Punch Reader is the only component that has been obtained on other than a rental basis. This item was purchased from the IBM Corporation at a cost of $39,750.

Maintenance and servicing of all rental equipment is provided by IBM Customer Engineers in accordance with the provisions of the two contracts cited above. Customer Engineers accomplish required preventive maintenance and such unscheduled maintenance as may become necessary, including the furnishing of replacement parts. The cost of such maintenance is included in the rental rate.

Customer Engineers also accomplish required preventive and unscheduled maintenance on the 9307 Tape Punch Reader. This is provided under the terms of a separate IBM maintenance agreement at the current rate of $165 per month.

Basic System

Machine	Name	Rental Rate
704	Central Processing Unit	$9,845
711	Punched Card Reader	800
716	Alphabetic Printer	1,200
721	Punched Card Recorder	600
727(10)	Magnetic Tape Unit	550 ea
733	Magnetic Drum Unit	2,900
736	Power Frame No. 1	1,100
738	Magnetic Core Storage Unit	19,700
741	Power Frame No. 2	1,400
746	Power Distribution Unit	1,300
753	Tape Control Unit	2,350
	Total	$46,695

Additional Equipment

714	Card Reader	$1,500
720	Printer	1,400
727(2)	Magnetic Tape Units	550 ea
747	TDS Power Supply	500
759	Card Reader Control Unit	900
760	Control & Storage Unit (720)	2,500
774	Tape Data Selector	2,324
	Total	$10,224

The 9307 Tape Punch Reader and its supporting power supply were purchased at a total cost of $39,750. These two items are classified as additional equipment.

PCAM Components

010	Binary Punch	$10
026(5)	Printing	63 ea
026(2)	Printing Card Punch	60 ea
047	Tape Controlled Card Punch	160
056(2)	Card Verifier	53 ea
056	Card Verifier	50
063	Card Controlled Tape Punch	75
083	Card Sorter	134
089	Alphabetic Collator	220
407	Accounting Machine	995
519	Document Originating Machine	319
552	Card Interpreter	90
	Total	$2,594
	Grand total, all rental equipment:	$59,513

USAF Kirtland AFB

Basic System	Rental
704	$9,720
736	1,100
741	1,400
746	1,300
738	19,700
711	800
721	600
716	1,200
Additional Equipment	
753	$2,440
727	3,300

Argonne

The 704 configuration which Argonne National Laboratory has is as follows:

32,768 word core; 8,192 word drum; 9 on-line tape units (727); on-line: 711 Card Reader, 721 Output Punch, and 716 On-line Printer; off-line: Card-to-Tape (714 Card Reader), and Tape-to-Printer (717 Printer).

BFS FAA

Basic System

704	Central Processing Unit	1
711	Card Reader	1
716	Printer	1
717	Printer	1
721	Card Punch	1
727	Tape Units	8
736	Power Supply	1
737	Core Storage	2
741	Power Supply	1
746	Power Unit	1
753	Tape Control	1
757	Printer Control	1

Total Monthly Rental - $32,555

Additional Equipment

026	Card Punch	2
056	Card Verifier	1
082	Sorter	1
407	Accounting Machine	1
514	Reproducing Punch	1

Total Monthly Rental - $1,255

NASA Ames

Basic System

704 Main Frame, 8K Magnetic Core, Printer, Reader, Punch, 5 Magnetic Tapes and Tape Control Unit rents at $28,795/month.

Additional Equipment

717, 757, and off-line printer rents at $2,050/month.

NASA Lewis

704, 736, 741, 746, 737 (2), 711, 721, 716, 733, 753, 727 (8) rents at $32,400/month.

717, 757, 727, 407, 519, 082, 026 (5), 011 rents at $3,900/month.

NBS

Basic System

704, 711, 716, 721, 727 (6), 733, 753, 738, 736, 741, and 746 rents at $44,450 1st shift.

Additional Equipment

776 Tape Switching Device $40 per shift, 1/2 word logic $500 per shift, and 717, 757, 727 Off-line Printer $2,350 per shift.

TVA

704, 711, 716, 727 (8), 753, 737 (4), 736, 741, and 746. Purchase price June 1960, $1,213,679.33. Price when new, $1,752,900.

714, 759, 717, 757, 722, 758, and 727 (2). $324,150 price when new if purchased. However, this equipment is leased from IBM, at price indicated.

$37,650/month rental paid for basic system during rental period.

$6,950/month for additional equipment.

Service charge is $3,099.75/month for equipment listed. This price applies to prime shift. Additional charges are paid for services outside the prime shift.

Allis-Chalmers

Basic System

704, 711, 716, 721, 753, 736, 741, 746, 740, and 780 rents at $27,000/month.

AVCO

Basic System

704, 738, 711, 716, 721, 753, 9-727. $54,000/month total system rental prime shift.

Additional Equipment

717 System, TDS 407, 519 System, 714 System rental included in above figure.

Bell Aero

Basic System

704, 8-727 Tapes, 2-737 Cores, 1-733 Drum, 1-716 Printer, 1-711 Reader, and 1-721 Punch rents at $33,245/month.

Additional Equipment

717 Printer, 714 Reader, plus basic EAM card preparation equipment $6,000/month.

Bell Tel Whippany

Basic System

704, 741, 736, 753, 716, 714, 722, 717, 720, 738, 746, 13-727, 711, 721, 759, 758, 757, and 760 . Total rental is $57,000/month.

Additional Equipment

083, 557, 6-026, 407, 087, 519, 3-056, and 101. Total rental is $3,000/month.

176 hours basic rental plus maintenance and service.

Bell Tel Murray Hill

Basic System

704, 738, 716, 711, 721, 736, 746, 741, 753, and 9-727's rents at $43,000/month.

Additional Equipment

717, 757, 720, 760, 714, 759, 722, 758, and 4-727's rents at $13,000/month.

Bendix Systems

Rental rate for Basic System

$38,285/month for 704, 736, 741, 746, 737, 711, 716, 721, 753, 727, and 733.

Additional Equipment

DIGITRON (for display purposes) $48,000 purchase cost. IBM 717, IBM 727 (one additional unit).

CEIR

Basic System

704, 721, 733, 736, 711, 727 (8), 737 (2), 741, 716, 753, and 746 cost $809,300.

Peripheral equipment shared by 704 and 709; 774, 720, and 714 cost $441,000.

Basic System

704, 716, 727 (8), 733, 736, 746, 711, 721, 753, 737, and 741 rents at $33,930.

Peripheral equipment shared by 704 and 709; 774, 720, and 714 rents at $12,707/month.

Convair Fort Worth

Basic System

Qty	Type	Prime Shift Rental
1	704	$9,795
1	711	800
1	716	1,200
1	721	600
10	727	5,500
1	733	2,900
1	736	1,100
1	738	19,700
1	741	1,400
1	746	1,300
1	753	2,350
	Total	$46,645

Additional Equipment

Qty	Type	Prime Shift Rental
1	714	$1,650
1	722	875
3	727	1,650
1	720	1,900
1	758	800
1	759	975
1	760	2,500
	Total	$10,350

Convair San Diego

Basic System

IBM 704 with 32K to 10 tapes rents at $43,000/month.

Additional Equipment

2 printers, one punch, and one reader rents at $10,000/month.

Douglas A-260

Main frame, 9 magnetic tape units, 1 reader, 1 printer, and 28,672 words additional core memory rents at $33,000/month.

Douglas A-850

Main frame, 6 magnetic tape units, 1 reader, 1 punch, and 1 printer and 28,672 words additional core memory rents at $32,625/month.

Douglas B-250

Main frame, 7 magnetic tape units, 1 reader, 1 punch, 1 printer and 28,672 words additional memory rents at $33,175/month.

GMC Warren

Basic System

704, 711, 716, 721, 727 (8), 733, 737 (2), 740, 753, 780. Total rent $36,130/month.

Additional Equipment

717 (2), 757, 714, 759, 722, 758, 727 (4), Tape Switching. Total rent $12,365/month.

GMC Indianapolis

Qty	Type		Monthly Rental
1	704	CPU Model I	$9,700
		Device Code 203 CAD	20
		Device Code 76 Back Space File	35
		Device Code 419 Flo Pt Trap	75
1	711	Card Reader Model I	800
1	716	Printer Model I (w/Fortran Symbols)	1,200
1	721	Card Punch (on line)	600
8	727	Tape Unit Model I at 550	4,400
1	733	Magnetic Drum Storage Model I	2,900
1	736	Power Supply Model II	1,100
1	737	Magnetic Core Storage Model I	3,700
1	737	Magnetic Core Storage Model II	3,700
1	741	Power Supply Model II	1,400
1	746	Power Distribution Unit Model II	1,400
1	753	Tape Control Model I	2,350
			$33,380

GMC Indianapolis

Qty	Type		Annual Gross
1	704	Central Processing Unit	$119,724
1	711	Model II Card Reader	9,744
1	716	Model I Printer	14,616
1	721	Model I Card Punch	7,308
8	727	Model I Tape Drives	53,016
1	733	Model I Drum Storage	35,316
1	736	Model II Power Supply	13,392
2	737	Core Storage	90,132
1	741	Model II Power Supply	17,052
1	746	Power Distribution Unit	15,828
1	753	Tape Control	28,620
		Grand Total	$404,748
		Monthly Total	$ 33,727

IBM CORNELL AERONAUTICAL LABORATORY

Description	Machine Type	Machine Serial	Mo. Chg.	Pur. Price New Of Equiv. Mach.	Monthly Reduction	Aged to Mar. 1 Mos.	Aged to Mar. 1 Pur. Price	Mo. Deprec-iation Based 80 Mo. Life	Maintenance 0-36	Maintenance 37-73	Maintenance 73-108
Cntrl Process	704	11026	10325.00	487500.00	4062.483	34	349375.10	4367.19	1149.75	1149.75	1149.75
Pnch Crd Reader	711	11034	800.00	32000.00	266.665	34	22933.33	286.67	63.25	79.75	96.50
Crd Reader	714	11136	1500.00	64450.00	537.081	25	51022.91	637.79	192.00	193.00	246.00
Alph Prntr	716	11028	1200.00	54200.00	451.664	34	38843.34	485.54	116.00	145.00	176.00
Printer	717	11108	1400.00	55000.00	458.331	25	43541.66	544.27	210.00	233.00	293.00
Pnch Crd Rcdr	721	11025	600.00	25000.00	208.332	34	17916.66	223.96	62.25	78.50	96.50
Mag Tape Unit	727	21536	550.00	18200.00	151.666	34	13043.33	163.04	119.00	120.00	128.0
Mag Tape Unit	727	21537	550.00	18200.00	151.666	34	13043.33	163.04	119.00	120.00	128.0
Mag Tape Unit	727	21538	550.00	18200.00	151.666	34	13043.33	163.04	119.00	120.00	128.0
Mag Tape Unit	727	21539	550.00	18200.00	151.666	34	13043.33	163.04	119.00	120.00	128.0
Mag Tape Unit	727	22662	550.00	18200.00	151.666	28	13953.33	174.42	119.00	120.00	128.0
Mag Tape Unit	727	22970	550.00	18200.00	151.666	25	14408.33	180.10	119.00	120.00	128.0
Mag Tape Unit	727	23321	550.00	18200.00	151.666	22	14863.33	185.79	119.00	120.00	128.0
Mag Drum Strg	733	11057	2900.00	110000.00	916.663	22	89833.34	1122.92	248.00	248.00	248.0
Power Frame No. 1	736	11025	1100.00	57200.00	476.664	34	40993.34	511.67	65.25	65.25	65.2
Mag Core Strg	737	10040	3700.00	192400.00	1603.326	40	128266.71	1603.33	133.00	133.00	133.0
Mag Core Strg	737	11047	3700.00	192400.00	1603.326	34	137886.71	1723.58	133.00	133.00	133.0
Crt Recorder	740	11030	2450.00	96000.00	800.00	8	89600.00	1120.00	215.00	215.00	215.0
Power Frame No. 2	741	11025	1400.00	72800.00	606.664	34	42173.34	652.17	44.50	44.50	44.5
Power Distr	746	11025	1400.00	72800.00	606.664	34	42173.34	652.17	28.25	28.25	28.2
Tape Cntrl Unit	753	11025	2350.00	80000.00	666.664	34	57333.34	716.67	224.00	224.00	224.0
Printer Cntrl	757	10051	650.00	44000.00	366.665	48	26400.00	330.00	88.75	88.75	88.7
Crd Reader Cntrl	759	10001	900.00	45000.00	374.998	55	24375.01	304.69	76.75	76.75	76.7
Spcl Edpm Unit	776	11016	125.00	7500.00	62.449	14	6625.00	82.81	-	-	-
CRT Recorder	740	11030	2450.00	96000.00	133.333	8	14933.36	186.66	54.00	65.50	65.5

Grumman

Basic System

IBM 704, 8K core, 8K drum, 10 tapes, full compl. on and off line equipment rents at $43,130/month.

Additional Equipment

IBM 650 MDDPM, key punches, verifiers, tabulators, reproducers, sorters, etc. rents at $8,000/month.

Gulf

Basic System

704, 711, 716, 721, 727 (8), 733, 736 (2), 738, 741 (3), 746 (3), and 753 rents at $46,000/month.

Additional Equipment

714, 717, 727 (2), 757, and 759 rents at $6,000/month. An additional $1,500/month is paid for punched card equipment.

2 IBM customer engineers on premises.

IBM PDL Poughkeepsie

Basic System

704	CPU
711	Card Reader
716	Printer
721	Card Punch
727 (10)	Tape Drives
733	Magnetic Drum
736	Power Supply
738	Core Storage
740	CRT Recorder
741	Power Supply
746	Power Distribution Unit
753	Tape Control
780	CRT Display

Total rental is $50,730/month.

Additional Equipment

720 (2)	Printers
760 (2)	Printer Controls
714	Card Reader
759	Reader Control
727 (3)	Tape Drives

Equipment is also used with 705II, 705III, and 305 Systems. Total rental is $13,500/month.

IBM GPD DL Endicott

Basic System

704, 721, 711, 716, 733, 736, 738, 741, 746, 753, 727 (9) rents at $46,580/month.

Additional Equipment

010, 026 (5), 056 (4), 082, 407, 519, 714, 759, 717, 757, 727 (3) rents at $9,693/month.

IBM RC Yorktown Heights

Basic System

736, 738, 741, 746 rents at $33,360/month.

Additional Equipment

711, 714, 717 (2), 716, 721, 722, 727 (13), 733, 757 (2), 758, and 759 rents at $23,000/month.

Marquardt

Basic System

IBM 704, 711, 716, 721, 727 (8), 733, 736, 737 (2), 741, 746, and 753. Total rental: $33,270/month.

Additional Equipment

010, 024, 026 (5), 056 (2), 077, 083, 407, 519, 552, 714, 727 (2), 720, 759, and 760. Total rental: $10,218/month.

Martin Denver

Basic System

704, 711, 716, 721, 727 (10), 733, 736, 737 (2), 741, 746, 753 rents at $34,500/month first shift.

Additional Equipment

727 (2), 714, 717 (2), 722, 757 (2), 758, 759 rents at $10,000/month first shift.

North American

Basic System

IBM Types: 704, 711, 716, 721, 727 (9), 733, 736, 737 (2), 741, 746, 753 rents at $33,420/month.

Additional Equipment

IBM Types: 714, 717 (2), 727 (3), 757 (2), 759 rents at $8,400/month.

Pratt and Whitney

Basic System

Qty	Type		Monthly Rental
1	704	Analytical Control Unit	$9,720/ea
1	711	Card Reader	800/ea
1	716	Printer	1,200/ea
1	717	Printer	1,400/ea
1	721	Card Punch	600/ea
8	727	Tape Units	550/ea
2	733	Magnetic Drum Storage	2,900/ea
1	736	Power Supply	1,100/ea
2	737	Magnetic Core Storage	3,700/ea
1	741	Power Supply	1,400/ea
1	746	Power Distribution Unit	1,400/ea
1	753	Tape Control	2,370/ea
1	757	Printer Control Unit	650/ea
			$38,240

Additional Equipment

2	727	Magnetic Tape Units	$ 550/ea
1	738	32K Magnetic Core Storage	19,700/ea
1	714	Card Reader	1,500/ea
1	759	Reader Control	900/ea
1	717	Printer	1,400/ea
1	757	Printer Control Unit	650/ea
			$25,250

The 738 32K Magnetic Core Storage replaced the two 737 units originally installed, and one 733 Magnetic Drum Storage was cancelled. Also, the rental on the 746 Power Distribution Unit was decreased to $1,300.

Rand

Basic System

Approximately $58,000/month for three shift operation.

Additional Equipment

Approximately $10,000/month for three shift operation.

Raytheon

4K core, 8K drum, 4 tapes rents at $27,480/month.

Socony

Basic System

Core storage, central processing unit, power & control units, 7 magnetic tape units, on line reader, punch, and printer rents at $42,020/month.

Additional Equipment

Off line card-tape, tape-card, and tape-printer rents at $9,900/month.

Standard Oil California

Basic System

Central processing unit (704), 8 magnetic tapes, drum, power supply, core storage (32K), core storage (8K), card reader and recorder rents at approx. $45,750/month.

Additional Equipment

Card Equipment	$1,600/mo.
Tape to Printer Converter	4,950/mo.
Card to Tape Converter	2,965/mo.

Standard Oil Indiana

704	Central Processing Unit
711	Punch Card Reader
716	Alphabetic Printer
721	Punch Card Recorder
727(6)	Magnetic Tape Unit
733	Magnetic Drum Storage
736	Power Frame No. 1
737(2)	Magnetic Core Storage
741	Power Frame No. 2
746	Power Distribution Unit
753	Tape Control Unit w/real time & typewriter
7271	Signal Converter

Total cost approximately $34,000/month

Temco

Approximate cost of system if purchased, for a 4 year old system is $939,000. This includes:

704	CPU
741	Power Frame
736	Power Frame
746	Power Distribution Unit
737-1	Core Unit (4,096 words)
737-2	Core Unit (4,096 words)
711	Card Reader
721	Card Punch
716	Printer
753	Tape Distribution Unit
733	Drum Unit (8,192 words)
727 (7)	Magnetic Tape Units

The system is rented at $32,730/month.

Additional equipment cost if purchased, would cost card-to-tape peripheral - $134,000, which includes 727 Tape Units, 714 Card Reader, and 759 Control Unit. Tape-to-punch, $89,500, which includes 727 Tape Unit, 722 Card Punch, and 758 Control Unit. Tape-to-printer $91,000, which includes 727 Tape Unit, 717 Printer, and 757 Control Unit. All these rent for $7,860/ month.

United Aircraft (3)

The basic system, consisting of 704 Central Processor, 711 Card Reader, 716 Printer, 721 Punch, 10 727 Mag Tapes, 733 Mag Drum, 736 Power Frame No. 1, 741 Power Frame No. 2, 746 Power Distributor, 753 Mag Tape Control, and 738 Mag Core Storage rents for $46,590/month.

Additional Equipment

714-759 Card Reader & Control, (2) 717-757 Printer & Control, 722-758 Card Punch & Control, and (2) 727 Mag Tape Units rents for $9,050/month.

Chance Vought

Basic System

Card reader, printer, punch, 9-tapes, ALU, 2-core, drum, ICU, and power rents at $33,990/month.

Additional Equipment

Reader, 2-printers rent for $8,400/month.

Westinghouse Baltimore

Basic System

Qty	Type		Monthly Rental
1	704	Central Processing	$9,795
1	711	Punch Card Reader	800
1	714	Card Reader	1,675
1	716	Alphabetic Printer	1,200
2	717	Printer	2,800
1	721	Punch Card Reader	600
11	727	Magnetic Tape Unit	6,050
1	736	Power Frame No. 1701	1,100
1	738	Magnetic Core Storage	19,700
1	741	Power Frame No. 2701	1,400
1	746	Power Distribution	1,300
1	753	Tape Control Unit	2,350
2	757	Printer Control Unit	1,300
1	759	Card Reader Control Unit	975
		Additional Equipment	
3	026	Printing Card Punch	$180
1	056	Verifier	50
1	514	Reproducing Punch	103
1	552	Alphabetical Interpreter	90

Cal Tech JPL

Basic System

The 704 CPU, 711, 716, 721, 7-727, 736, 738, 741, 746, and 753 cost $1,907,200 and rents at $42,400/ month.

Additional Equipment

717, 757, 026, 056, 082, 519, 557, and 010 cost $90,400 and rents at $3,200/month.

MURA

The IBM 704, 711, 716, 721, 727, 753, 733, 737, 736, 741, and 746 rents at $31,000/month.

PERSONNEL REQUIREMENTS

Manufacturer

Operator, programming, and technical training is available as well as assistance at all levels.

USA BMA (now NASA) (2)

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1/2	1/2	1/2
Operators	1	1	1
In-Output Oper	1	1	1

Operators are used on 704's , 705, 709 rotating shifts. Other personnel on 8 hrs. shift. Engineers rotate shifts - 704's - 709.

USA WSMR CO

	One 8-Hour Shift Used	One 8-Hour Shift Recommended	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recommended
Supervisors	2	2	1	1
Programmers	8	12	1	2
Operators	8	12	2	6
Technicians	3	3	0	0
In-Output Oper	8	12	2	6
Tape Handlers	8	12	2	6

Methods of training used include on-the-job training and operation plus intermittent programming classes.

USA WSMR

	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recommended
Supervisors	13	14
Analysts	22	25
Programmers	10	12
Clerks	1	1
Librarians	1	1
Operators	42	65
In-Output Oper	3	5

Operation tends toward closed shop.

Methods of training used are supervisory, on-the-job, and Operators Manuals and IBM Schools.

USN David Taylor

	One 8-Hour Shift Used	One 8-Hour Shift Recomm	Three 8-Hour Shifts Used	Three 8-Hour Shifts Recomm
Supervisors			1	3
Analysts	10	10		
Programmers	20	20		
Librarians	0.5	1		
Operators			3	3

Operation tends toward closed shop.

Methods of training used is on-the-job and the manufacturer.

USNOL White Oak

	One 8-Hour Shift Used	One 8-Hour Shift Recomm	Two 8-Hour Shifts Used	Two 8-Hour Shifts Recomm
Supervisors	1	1		
Operators	3	2	1	2

Operation tends toward open shop.

Both basic programming and automatic programming are taught by NOL personnel on a regular basis.

USAF Eglin AFB

	Three 8-Hour Shifts
Supervisors	1
Clerks	4
Operators	10
In-Output Operators	5

Operation tends toward closed shop.

Methods of training used includes IBM schools, local schools, and on-the-job training.

USAF Edwards AFB

	Two 8-Hour Shifts Used	Recommended
Supervisors	2	3
Analysts	4	
Programmers	14	
Clerks	1	3
Operators	4	6
In-Output Operators	2	3

Operation tends toward open shop.

USAF SAC Offutt

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts	
	R	R	U	Rec
Supervisors	5	6	6	6
Analysts	*	*	0	*
Programmers	*	*	22*	*
Coders	*	*	*	*
Clerks	5*	7*	7*	7*
Librarians	*	*	*	*
Operators	3	5	7	7
Engineers	3	4	4	5
Technicians	3	3	3	3
In-Output Oper	1	2	4	4
Tape Handlers	*	*	*	*

It is considered unlikely that either the same functional alignment or the exact number of personnel of any one classification as are peculiar to this installation would be appropriate to another computer installation of approximately the same equipment configuration. This is considered to be particularly true of many computer installations which have been designed expressly for military operations, which are usually less routine and more subject to changing concepts, fluctuating requirements and irregular periods of peak activity, than would normally apply to the typical commercial type facility.

Those items marked with an * indicate incompatibility with our mode of operation or interpretation of job classification. For example: although no analysts are presently assigned to or physically working under the direct jurisdiction of the Chief Programmer, the analyst job-function is, never-the-less reflected in computer output. Many of the programs now in being were created with varying degrees of analyst-type consultation and advisement. In addition, this computer system, while assigned to the Control Division of the Directorate of Operations is actually utilized by many other staff agencies, either in direct or indirect support of the SAC mission. In some cases, the only computer-personnel support available to these agencies is that actually assigned to this office. In numerous cases, however, these agencies have their own force of programmers and/or analysts and use only the processing facilities of the computer system for either PCAM activities, program assemblies, testing, production, etc. In other cases, only the work-statement is furnished to the Chief Programmer, and the entire work-effort is accomplished by personnel assigned to this facility and the finished product then furnished to the requesting agency.

Our mode of operation is such that usually it is difficult to differentiate between the functions of programming and coding; therefore, personnel, both military and civilian, assigned to either of these functions have been listed as programmers.

The function of librarian is performed as an additional duty of personnel assigned primarily to other duties.

Few of the personnel assigned or attached to the computer Machine Section, serve exclusively in any one of the specialized functions cited above. Through extensive cross-training, many of these personnel are fully qualified in many fields of machine application and from time to time may be assigned varying duties, all or any of which may fall into the specialized classifications listed above.

The figures given under Clerks includes PCAM key punch operators.

Due to the number of variables involved, we do not feel that we can constructively state more inclusive recommendations for single or two-shift operations.

Operation tends toward closed shop.

Routine on-the-job training procedures are utilized, with each person's training program being geared to his individual job assignment and personal qualifications. Attendance of appropriate military or company (IBM) training or orientation courses is employed as training media whenever practicable.

USAF Kirtland AFB

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts
	U	Rec	U	Rec	Rec
Supervisors	3	3	3	4	5
Programmers	17	35	17	70	105
Clerks	1	2	1	3	4
Librarians	1	1	1	2	2
Operators	3	3	3	5	7
Engineers	2	2	2	2	3
Tape Handlers	0	1	0	2	3

Operation tends toward open shop.

Methods of training used include IBM schools and on-the-job training.

BFS FAA

	One 8-Hour Shift		Two 8-Hour Shifts	Three 8-Hour Shifts
	U	Rec	Rec	Rec
Supervisors	3	6	9	12
Analysts	0	2	4	6
Programmers	6	20	40	60
Clerks	1	3	4	5
Librarians	1	2	3	4
Operators	3	3	6	9
Engineers	2	2	2	3
In-Output Op	1	1	2	3
Tape Handlers	1	1	2	3

Operation tends toward closed shop.

For inexperienced programmers - 6 months training, including 704 formal programming school; 3 weeks in machine room; 6 weeks advanced program training; the rest of the time spent in system training and specific programs. For experienced programmers - from 3 to 6 months training.

We have a requirement for pure mathematicians of Master's Degree level. We give our mathematicians and systems analysts approximately one year in programming before they are considered qualified to do the work required of them.

We also attempt to send all of our secretaries, librarians, audit clerks, etc., to a 704 school for familiarization purposes.

We are currently on a one-shift operation.

NASA Ames

Our current programming staff is about 75 percent open shop. Specifically these people are full time programmers administratively attached to branches other than the computing branch. In addition we have a small group of engineers who have been trained most recently in the use of a computer. Because of the large percentage of open-shop personnel, the greatest problem is training people as programming consultants. Within our own staff we suffer from a severe lack of systems programmers.

	One 8-Hour Shift Used	Recommended
Supervisors	2	2
Analysts	4	4
Programmers	15	20
Coders	0	3
Clerks	1	1
Librarians	0	1
Operators	3	3

Operation tends toward closed shop.

Training has been by group classes with individual assistance for a single new employee. This has been supplemented by seminars and general information sessions. Operators have always been given on-job training, the original group being trained in the installation by IBM.

NASA Lewis

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts	4	6
Programmers	18	26
Coders	30	40
Clerks	0	1/2
Librarians	0	1/2
Operators	3	6

These figures are closed shop personnel. About 150 scientists and engineers also submit problems on an "open-shop" programming basis.

Operation tends toward closed shop.

Methods of training used for supervisors, analysts programmers, - professional degree plus on-job training plus IBM courses. All others - on-the-job training.

NBS

	Three 8-Hour Shifts
Supervisors	4
Analysts	7
Programmers	9
Coders	6
Clerks	4
Librarians	1
Operators	5
In-Output Operators	7

NBS Computer Laboratory personnel only.

Operation tends toward open shop.

Methods of training used includes on-job training and in-hours courses.

NSA

	One 8-Hour Shift
Supervisors	1
Operators	1
Engineers	1
Technicians	1

Methods of training used includes formal classes and on-the-job training.

TVA

	One 8-Hour Shift
Supervisors	1
Librarians	1
Operators	1
Engineers	2
In-Output Operators	2
Tape Handlers	1

TVA maintains an open shop operation with some divisions supplying their own analysts, programmers and coders. The Computing Center maintains a Scientific Applications Section and a Business Applications Section for assistance in analysis, programming, and coding.

TVA's 704 is manned on a 24 hour schedule for the Power Generation Scheduling, which requires about five minutes of machine time per hour. The work load is such that one person each for the second and third shifts is sufficient to maintain both on-line and off-line operations.

Operation tends toward open shop.

Methods of training used: The following classes are offered periodically:

- Introduction to the 704 (2 days)
- FORTRAN (3 days)
- Detailed 704 Programming (2 weeks)
- Input/Output Conversion Techniques (20 hrs.)
- SURGE (2 days)
- Matrix Algebra
- Linear Programming
- Numerical Analysis

Refresher courses are offered periodically in College Algebra, Trigonometry, Calculus, Differential Equations and Statistics.

Matrix algebra, linear programming, numerical analysis and the refresher courses are offered either during working hours, or as after hours classes. After hours classes may be TVA sponsored, or jointly sponsored by TVA and U. of Chattanooga as college credit courses.

Allis-Chalmers

	One 8-Hour Shift
Supervisors	1
Analysts, Programmers & Coders	14
Clerks	2
Operators	1

Operation tends toward closed shop.

Methods of training used is work with experienced person.

AVCO

	Three 8-Hour Shifts
Supervisors	1
Programmers	18
Clerks	2
Librarians	1
Operators	5
Engineers	3

Operation tends toward closed shop.

Method of training is in-shop training.

Bell Aero

	One 8-Hour Shift Used	Recommended
Supervisors	2	
Analysts	2	4
Programmers	7	10
Coders	2	5
Operators	1	2
In-Output Operators		1

Operation tends toward closed shop.

Methods of training used includes 2 weeks programming school under IBM instructors, 1 week school under our instructors, and 6 months to one year work with an experienced programmer.

Bell Tel Whippany

	One 8-Hour Shift
Supervisors	1
Analysts	open shop
Programmers	open shop
Coders	open shop
Clerks	4
Librarians	1
Operators	3
Engineers	open shop
Technicians	open shop

Five operators are used for two 8-hour shifts.

Operation tends toward open shop.

Methods of training used includes IBM training courses and previous employment experience.

Bell Tel Murray Hill

	Three 8-Hour Shifts Used	Recommended
Supervisors	4	
Analysts-Programmers	20	20
Coders	3	5
Clerks	2	5
Librarians	1	
Operators	8	

Operation tends toward open shop.

Methods of training used are in-house courses in Fortran, Sap.

Ours is a fairly standard 704 installation. The primary distinguishing feature is that we operate virtually completely within the BE-SYS-2 monitor program, which provides automatic job-to-job sequencing from a stacked input tape, incorporation of Fortran, Sap and a 650 simulator as sub-systems, snapshot dumping facilities, and automatic merit rating of human operators.

Bendix Systems

	One 8-Hour Shift Used	Recomm	Two 8-Hour Shifts Used	Recomm
Supervisors	1	1	1	1
Analysts	8	8	9	9
Programmers	12	12	15	15
Clerks	1.5	1.5	2.5	2.5
Librarians	0.5	0.5	0.5	0.5
Operators	2	2	3	3

Operation tends toward open shop.

Inexperienced programmers attend a two and one half (2 1/2) week class taught by International Business Machines Corporation. No training is given to 704 or 709 Systems experienced programmers.

CEIR

	One 8-Hour Shift U	R	Two 8-Hour Shifts U	R	Three 8-Hour Shifts U	R
Supervisors	1	1	2	2	3	3
Programmers	17	17	17	17	17	17
Clerks	1	1	1	1	1	1
Librarians	1	1	1	1	1	1
Operators	1	1	2	2	3	3
In-Output Op	1	1	2	2	3	3

For the purpose of personnel reports, our staff was cut in half, since we have both an IBM 704 and IBM 709. We have a dispatcher, program librarian, magnetic tape librarian, etc., to cover both computers.

Operation tends toward open shop.

Operators are given on-the-job training. Programmers are given a 6-months course, evenly divided between formal classes and on-the-job training.

Convair Fort Worth

	Three 8-Hour Shifts Used	Recommended
Supervisors	1	2
Analysts	10	10
Programmers	23	25
Clerks	0.5	1
Librarians	0.5	1
Operators	3	5
In-Output Operators	3	4

Operation tends toward closed shop.

Inexperienced personnel are given "on-job" training. They are apprenticed to experienced personnel for periods of three to six months as required.

Cornell Aero

	One 8-Hour Shift
Supervisors	1
Analysts-Programmers	7
Operators	3

Supervisor responsible for training of personnel.

Convair San Diego

	One 8-Hour Shift U	R	Two 8-Hour Shifts R	Three 8-Hour Shifts R
Supervisors	3	3	4	5
Analysts	3	3	4	4
Prog. & Cod	20	30	45	55
Clerks	1	1	1.5	2
Librarians	0	0	0.5	1
Operators	3	3	5	7

Operation tends toward closed shop.

Methods of training used are small classes.

Douglas A-260 (2)

	One 8-Hour Shift
Supervisors	1
Analysts, Prog. Coders	20
Clerks	1
Operators	4

Figures are for each system.

Operation tends toward closed shop.

Method of training is own course followed by on-the-job training.

Douglas B-250

	One 8-Hour Shift
Supervisors	2
Analysts, Prog. Coders	25
Clerks	1
Operators	4

Operation tends toward closed shop.

Method of training is own course followed by on-the-job training.

GE Evendale

	First 8-Hour Sft	Additional for Second 8-Hr Sft	Additional for Third 8-Hr Sft
Supervisors	10	1	0
Analysts	29	0	0
Programmers	28	0	0
Coders	5	0	0
Clerks	7	0	0
Librarians	1	0	0
Operators	2	1	1
Engineers	3	1	on call
In-Output Op	2	2	1

90% of programming is done by computations personnel. About 250 engineers and engineering assistants have been trained in FORTRAN. About 100 accountants and procedures personnel have been trained in SURGE, a data processing language. Plans call for more extensive training of Division personnel in these and new problem oriented languages.

Operation tends toward closed shop.

Two full time training specialists are used plus some part time activity. Basic training consists of FORTRAN, SURGE, and SAP. Rate dependent on individual.

GE Schenectady

	One 8-Hour Shift Used	Recommended
Supervisors	2	2
Analysts	8	8
Programmers	30	32
Clerks	8	8
Librarians	1	1
Operators	3	3
Engineers	2	6

Five operators are used and recommended for two 8-hour shifts.

Operation tends toward open shop.
Methods of training used includes formalized training in systems used, plus seminars to keep everyone up to date.

GMC Warren

	One 8-Hour Shift
Supervisors	4
Analysts, Prog. & Coders	35
Clerks	11
Librarians	1

Nine operators are used for two 8-hour shifts.
Operation tends toward open shop.
Methods of training used includes a 3-day FORTRAN course, taught every six weeks, supplemented by on-the-job training.

GMC Indianapolis

	One 8-Hour Shift		Two 8-Hour Shifts	
	U	Rec	U	Rec
Supervisors	4	3	4	4
Analysts	2	3	2	3
Programmers	7	10	7	10
Coders	0	3	0	3
Clerks	1	1	1	1
Librarians	1	1	1	1
Operators	1	2	2	4
Engineers	1	1	1	1
In-Output Op	0	1	0	2

Operation tends toward closed shop.
Methods of training used includes IBM schools and on-the-job training.

GMC Indianapolis

	Two 8-Hour Shifts
Supervisors	4
Analysts	3
Programmers	10
Clerks	1
Operators	4
Technicians	1
In-Output Oper	4
Tape Handlers & Stock Clerks	2

The personnel requirements as outlined above deserve the following explanation:
Supervisors (4): 1 - Manager of Data Processing (This includes responsibility for not only 705 operations and programming, but also all of EAM operations); 2 - General Supervisor of EDP; 3 - Supervisor of 705 Operations; 4 - Supervisor of 705 Programming.
Programmers: This total of 10 programmers is not a normal requirement. Straight maintenance and improvement on an established computer should require somewhat less than 10. By the same token, changing from one generation computer to another will, in most cases, call for a substantial increase to the programming staff. Actual programming effort at Allison, under the present circumstances and including temporarily assigned personnel for our conversion period is presently at 18.
Operation tends toward closed shop.
Methods of training used includes IBM programming classes held on the premises. All other training has been on-the-job type.

Grumman

	First 8-Hour Shift		Second 8-Hour Shift	
	Used	Recomm	Used	Recom
Supervisors	6	6	6	7
Anal., Prog, C	10	15	0	1 or 2
Clerks	1			
Operators	2		2	
In-Output Op	1			

In addition to the above personnel we have 9 girls in the support area (keypunching, verifying, operation of EAM equipment).
Operation is open shop.
Programming classes in FORTRAN given to open shop engineering programmers. Computing Section personnel available for consultation, guidance, and aid in debugging operations. Operating personnel trained on-the-job.

Gulf

	One 8-Hour Shift
Supervisors	3
Analysts	2
Programmers	16
Clerks	5.5
Librarians	0.5
Operators	2
In-Output Operators	1

In the second 8-hour shift, 1 additional operator is required. Two are recommended.
Figures quoted are for "closed shop" personnel. Personnel quoted as programmers are considered to be programmer-analysts. We have trained about 225 open-shop personnel in the FORTRAN system. More than one-third of these have been programming.
We have our own training group which trains our programmers. We use IBM training for first pass on new equipment. Our training group also gives a 20-hour FORTRAN class to about 50 people twice a year.

IBM PDL Poughkeepsie

	One 8-Hour Shift	Three 8-Hour Shifts
Supervisors		6
Analysts	5	
Programmers	10	
Coders	5	
Clerks	18	3
Librarians		1
Operators		18
Engineers	20	
In-Output Oper	25	7
Tape Handlers		3

Figures are for three IBM 700-Series systems.
Personnel figures reflect figures for machine operations only. The 3 systems are tightly interlocked so that supervisory, clerical, input/output operators are utilized with the 3 systems.
Programming groups are divided into two general areas - Design Automation and Scientific Computation.
Production coordination is accomplished by utilizing an Engineering Process Control Group. This is a technical-clerical group responsible for coordinating all work between computing groups and engineering in general.
Operation tends toward closed shop.
Methods of training used includes customer training programs - IBM Sales, on-the-job training, and departmental programming and operation courses.

IBM GPD DL Endicott

	One 8-Hour Shift
Supervisors	4
Analysts, Programmers, Coders	25
Clerks	1
Librarians	1
Technicians	1

Nine operators and 3 engineers are required for 6 day, 3 shift operation.
Operation tends toward closed shop.
Operators are given on-the-job training and programmers attend a programming class conducted by department personnel.

IBM San Jose

	Three 8-Hour Shifts
Supervisors	1
Analysts	2
Programmers	3
Clerks	2
Librarians	1
Operators	6

Operation tends toward open shop.

Marquardt

	One 8-Hour Shift
Supervisors	2
Analysts	2
Programmers	10
Coders	1
Clerks	3
Operators	3

An additional operator is required for a second 8-hour shift.

Martin Denver

	One 8-Hour Shift
Supervisors	7
Analysts	2
Programmers	35
Clerks	8
Librarians	3
Operators	17

An additional two operators are required for the second 8-hour shift and an additional one for a third 8-hour shift.

Operation tends toward closed shop.

Most classes are presented by the computer organization in connection with on-the-job training; for new equipment - classes conducted by the manufacturer.

North American

	One 8-Hour Shift
Supervisors	2
Analysts	7
Programmers	10
Coders	10
Clerks	3
Librarians	1
Operators	2
Engineers	3
Technicians	1
In-Output Operators	2
Tape Handlers	2

Methods of training used includes classes and on-the-job training.

Pratt and Whitney

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	3	5
Analysts	21	30
Programmers	4	0
Coders	10	12
Clerks	2	3
Librarians	0	2
Operators	4	6
Engineers	3	4
Technicians	1	1

Operation tends toward closed shop.

Inexperienced personnel are trained by two IBM Applied Science Representatives with supplementary training given by our Systems group. New experienced personnel are indoctrinated by our Systems group. Weekly meetings are held to keep the entire group abreast of all new developments.

Rand

	Three 8-Hour Shifts
Supervisors	3
Analysts	5
Programmers	40
Coders	8
Clerks	3
Librarians	1
Operators	5
Engineers	3
Technicians	3
In-Output Oper	2

Operation tends toward closed shop.

Methods of training includes for complete novices, a standard short course in computing (one man per class) for 3-6 weeks, plus apprenticeship to experienced man.

Raytheon

	One 8-Hour Shift
Supervisors	1
Analysts	2
Programmers	10
Clerks	1
Librarians	1
Operators	2
Engineers	1

Operation tends toward closed shop.

Methods of training used are IBM training courses and on-the-job training.

Republic Aviation

	One 8-Hour Shift	
	Used	Recommended
Supervisors	5	
Analysts	5	
Programmers	35	
Coders	2	
Clerks	5	7
Librarians	0	1
Operators	3	4
Engineers	3	3
In-Output Operators	7	7

Supervisor category does not include manager, Digital Computing & Data Processing Division. Number of analysts shown include only those directly engaged in Applied Mathematics. Programmers shown are all program-analysts for engineering applications, business applications and programming techniques. Coders only during training period. Clerks include secretaries and schedulers. Operators include console, tape and peripheral equipment operators. Customer engineers supplied by IBM. In-Out operators include 6 key punch operators and one tape operator.

For two 8-hour shifts, 5 operators are used, 6 recommended. For three 8-hour shifts, 7 operators are used, 8 recommended. One additional engineer is used for the second and third shifts. Two additional engineers are recommended when going to three 8-hour shift operations.

Operation tends toward closed shop.

Methods of training used are primarily in-plant training classes, supplemented by off-site training classes held by manufacturer; off-site conferences - Share, ACM, AMS, etc.

Sandia

	Two 8-Hour Shifts
Supervisors	3
Programmers	29
Operators	8

Operation tends toward closed shop.

Method of training used is on-the-job.

Socony

	One 8-Hour Shift
Supervisors	3
Programmers	10
Coders	1
Clerks	1
Operators	1
In-Output Operators	1

One additional operator each is used for the second and third shifts. Two are recommended. Two operators should be used for the first shift.

Operation tends toward open shop.

Programmers are trained by IBM Programmers Schools, supplementary programming lectures for new programmers, and training assignments in programming. Operators are trained on-the-job.

Standard Oil California

	One 8-Hour Shift
Supervisors	3
Analysts	7
Programmers	7
Clerks	1
Librarians	1
Operators	3
Technicians	4

Five operators are required for two shift operation. Six operators are required for three shift operation. Eleven programmers are recommended.

Operation tends toward open shop.

Personnel are trained by internal Computer Center staff and by IBM training courses.

Standard Oil Indiana

	One 8-Hour Shift
Supervisors	8
Analysts	10
Programmers	5
Clerks	1

Two operators are used for two 8-hour shifts.

Operation tends toward open shop.

Methods of training used include IBM schools and on-the-job experience.

There are approximately 20 people outside of the computer group who program for and make use of computer facilities.

Temco

	One 8-Hour Shift	
	Used	Recommended
Supervisors	10	
Analysts	16	21
Programmers	15	20
Clerks	2	3
Librarians	0	1
Operators	6	8
Technicians		1

Operation tends toward closed shop.

Methods of training used includes formal classes and on-the-job.

United Aircraft (3)

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	U	R	U	R	U	R
Supervisors	11	12	12	13	12	13
Anal, Pro, C	62	79	62	79	62	79
Clerks	17	20	17	20	17	20
Librarians	1	1	1	1	1	1
Operators	5	6	10	11	11	12
In-Output Op	14	17	17	20	17	20

Figure for librarian is also included in Analysts-Programmers-Coders, since librarian duties are part-time. Supervisors do not include management-level personnel. Peripheral equipment operators are included in operators. The figure for Input-Output Operatorsis for keypunchers, verifiers only. Engineers and technicians are supplied by computer manufacturer.

Operation tends toward open shop.

Analysts are trained by on-the-job training (with supervision), a course in Algebraic Language, and a course in Machine Language. Outside programmers are given an Introduction to Machine Computations Course and a course in Algebraic Language.

Chance Vought

	Three 8-Hour Shifts
Supervisors	3
Analysts	5
Programmers	10
Coders	7
Clerks	1
Operators	14

Operation tends toward closed shop.

Methods of training used are on-the-job and 1% class work.

Westinghouse Baltimore

	One 8-Hour Shift
Supervisors	2
Analysts	6
Programmers	9
Clerks	1
Operators	2
In-Output Operators	1
Secretary	1

Operation tends toward closed shop.

The method of training used is primarily on-the-job, however a few selected personnel (5) have been sent to summer courses in numerical analysis. Additional personnel have been trained in programming by the manufacturer. Other personnel have taken evening education programs and university training at nearby schools.

Westinghouse East Pittsburgh

	One 8-Hour Shift
Supervisors	10
Analysts	25
Programmers	20
Coders	3
Clerks	3
Operators	2
Engineers	15
Technicians	8
In-Output Operators	1
Key Punch	4

Three additional operators are used for the second 8-hour shift and one for the third.

Operation is 1/4 open shop and 3/4 closed shop.

Cal Tech JPL

	One 8-Hour Shift	
	Used	Recommended
Supervisors	4	5
Analysts-Prog-Coders	25	30
Clerks	3	5
Operators	3	3
Key Punch Operators	2	2

One additional operator each is used for the second and third 8-hour shifts. The operators handle all IBM 704 peripheral equipment.

Operation tends toward closed shop.

MURA

	One 8-Hour Shift
Supervisors	1
Analysts	2
Programmers	6
Operators	4

Operation tends toward open shop.

Seminars are conducted for training purposes.

Ohio State

	One 8-Hour Shift
Supervisors	3
Analysts	5
Programmers	15
Coders	20
Clerks	3
Librarians	1
Operators	2
Engineers	2

Operation tends toward closed shop.

TEES

	One 8-Hour Shift
Supervisors	1
Analysts	5
Librarians	1
Operators	1

Programmers, coders and clerks are students and faculty.

Operation tends toward open shop.

Our own educational facilities are used for training. Regularly scheduled college courses in the field of computer and data processing are held.

U of Cal Los Alamos

	One 8-Hour Shift
Supervisors	7
Analysts	8
Programmers	17
Coders	7
Clerks	1
Librarians	1

Eight operators are used for three 8-hour shifts.

Operation tends toward open shop.

Programming courses are offered as the need arises.

U of Cal Berkeley

	One 8-Hour Shift
Programmers	7
Coders	1
Clerks	1
Librarians	1
Engineers	3

Ten operators are used for three 8-hour shifts.

Operation tends toward open shop.

Methods of training used include classes and on-the-job training.

U of Mich

Engineers	supplied by manufacturer
Academic appointees	4
Clerical & keypunching	3
Operators	3
Part time graduate assistants	10
Full time programmers	1

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USA BMA (now NASA) (2)

Good time 176.3 Hours/Week (Average)
Attempted to run time 180.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.977
Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 20 Jan 58
Time is not available for rent to outside organizations.
Hours are included for 2 704's.

USA WSMR CO

Average error-free running period 40 Hours
Good time 68.5 Hours/Week (Average)
Attempted to run time 70 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.978
Above figures based on period 1 Feb 60 to 1 May 60
Passed Customer Acceptance Test 10 Oct 59
Time is available for rent to outside organizations.

USA WSMR

Good time 52.11 Hours/Week (Average)
Attempted to run time 52.63 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.99
Above figures based on period 1 Mar 60 to 30 Apr 60
Passed Customer Acceptance Test 5 Oct 59
Time is not available for rent to outside organizations.

USN David Taylor

Good time 114 Hours/Week (Average)
Attempted to run time 120 Hours/Week (Average)
Operating ratio 0.96
Above figures based on period 1 Jul 59 to 31 May 60
Passed Customer Acceptance Test Nov 58
Time is available for rent to qualified outside organizations.

USNOL White Oak

Good time 54 Hours/Week (Average)
Attempted to run time 58 Hours/Week (Average)
Operating ratio 0.93
Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 2 Feb 59
Time is available for rent to outside organizations.

USAF Eglin AFB

Good time 132.7 Hours/Week (Average)
Attempted to run time 168 Hours/Week (Average)
Operating ratio 0.80
Above figures based on period 1 Jan 60 to 1 Apr 60
Passed Customer Acceptance Test 8 Mar 58
Time is not available for rent to outside organizations.

USAF Edwards AFB

Good time 83 Hours/Week (Average)
Attempted to run time 85.2 Hours/Week (Average)
Operating ratio 40 to 1
Above figures based on period 1 Jan 60 to 30 Apr 60
Passed Customer Acceptance Test 20 Feb 58
Time is not available for rent to outside organizations.

USAF SAC Offutt

Operating ratio 0.85
Above figure based on period 1 Sep 59 to 29 Feb 60
Passed Customer Acceptance Test May 57
Time is not available for rent to outside organizations.

A figure for average error-free running period would be unrealistic and possibly misleading. For example, two such periods might be 1 hour and 100 hours, respectively: the resulting average of 50 1/2 hours would not be realistic.

USAF Kirtland AFB

Average error-free running period Month
Good time 298.9 Hours/Week (Average)
Attempted to run time 302.0 Hours/Week (Average)
Operating ratio 0.989
Above figures based on period 1 Nov 59 to 30 Apr 60
Passed Customer Acceptance Test Aug 57
Time is not available for rent to outside organizations.

BFS FAA

Average error-free running period 21.3 Hours
Good time 30.6 Hours/Week (Average)
Attempted to run time 33.6 Hours/Week (Average)
Operating ratio 0.91
Above figures based on period 1 Jun 60 to 30 Jun 60
Passed Customer Acceptance Test 15 Feb 60
Time is available for rent to qualified outside organizations. Limited time is available on 3rd shift with no priority. This is subject to negotiation of proper contract.

NASA Ames

Good time	41 Hours/Week (Average)
Attempted to run time	42.5 Hours/Week (Average)
Operating ratio	0.964

Above figures based on period 1 Jan 60 to 1 Apr 60
Passed Customer Acceptance Test 22 Sep 58
Time is not available for rent to outside organizations.

We have not kept statistics to accurately determine an error-free running period. However, we have been extremely pleased with reliability.

NASA Lewis
60, 63.6, 0.941, 1 Dec 59 to 1 May 60, 27 Apr 59, not available.

NBS
122, 128, 0.953, 1 Apr 59 to 31 Mar 60, is available to qualified organizations.

NSA
38.0, 39.3, 0.968, 1 Jan 60 to 31 Jan 60, not available.

TVA
Approximately 40 hours, 55, 56, 0.98, Jan 60 to Jun 60, 4 Jun 58, is available.

Upon request, contractual arrangements for use of the machine may be made with outside organizations.

Allis-Chalmers
26.8, 27, 0.993, 1 Apr 59 to 1 Apr 60, May 58, time is available.

AVCO
110, 120, 0.92, Jan 60 to present, Aug 58, time is available.

Bell Aero
37, 40, 0.925, Dec 57 to Jul 60, 1 Dec 57, time is available.

Bell Tel Whippany
3 days (2 shifts/day), 75, 90, 0.833, Dec 59 to Apr 60, 23 Dec 59, is not available.

Bell Tel Murray Hill
75, 79, 0.95, 4 Jan 60 to 30 Jan 60, Mar 58, is not available.

Bendix Systems
50, 49.5, 0.99, 14 Sep 59 to present, 15 Sep 59, time is available.

All work performed on cost plus fixed fee basis including machine time, operating labor, and programming analysis labor.

CEIR
57, 62.5, 0.91, 1 Jan 59 to 1 Jan 60, Feb 57, time is available.

The workload varies from week to week depending on the requirements.

Convair Fort Worth
108, 112, 0.964, Sep 56 to Jan 60, 18 Mar 57, is not available.

Cornell Aero
35-38, 40, 0.912, 59 to 60, 57, time is available.

Convair San Diego
78, 83, 0.94, 1 Jan 60 to 15 May 60, Jan 57, time is available.

Douglas A-260
6 Hrs, 110, 115, 0.95, Jul 59 to Jul 60, Jun 57, time is available.

Douglas A-850
8 Hrs, 110, 115, 0.95, time is available.

Douglas B-250
8 Hrs, 110, 115, 0.95, Jul 59 to Jul 60, May 57, time is available.

GE Evendale
98, 100, 0.98, 1 Jan 60 to present, Jan 56, time is available.

GE Schenectady
69.8, 73.2, 0.95, 1 Jan 60 to 26 Jun 60, Jun 56, time available to qualified organizations.

Have run 3 month on 3 shift operation. At present are running on two shifts. Attempted to run time is good time plus machine error and bad tape time.

GMC Warren
1 Hr, 61.3, 68.7, 0.892, Mar 60 to May 60, May 56, available to qualified organizations.

GMC Indianapolis
7 Hrs, 54, 58.6, 0.92, 18 Apr 60 to 13 May 60, 15 Nov 59, available to qualified organizations.

GMC Indianapolis
81.3, 93.0, 0.874, 21 Jun 60 to 20 Jul 60, 15 Jan 57, available to qualified organizations.

Because of our present plans involving the IBM 7090 delivery, rental of 705 or 704 computer time is not now considered. Available time could be used by other Divisions of General Motors Corporation.

Grumman
68, 75, 0.91, Jan 60 to May 60, 1 Aug 58, is not available.

Gulf
0.95, Mar 59 to Aug 60, time is available.

We use the system presently about 130 hours/month ourselves and rent about 100 hours/month to outside users. Peripheral equipment added in October 1959.

IBM PDL Poughkeepsie
95.9, 105.3, 0.911, 1 Jan 60 to 27 May 60, Aug 59, is not available.

Attempted to run time is based on actual productive work time of computer which does not include maintenance, idle time, power failure, etc. Good time is productive time less setup and machine rerun.

IBM GPD DL Endicott
70 Hrs, 118, 122, 0.967, 26 Mar 60 to 20 May 60, Mar 57, is not available.

IBM San Jose
90, 91, 0.989, 1 May 60 to 31 Jul 60, 8 Feb 60, time is available.

IBM RC Yorktown Heights
Passed Customer Acceptance Test Aug 56
Time is not available.

Lockheed Marietta
92.21, 102.50, 0.90, 1 Jan 60 to 1 May 60, time is available to qualified organizations.

Marquardt
40, 41, 0.98, 1 Jan 60 to 1 Apr 60, Dec 57, time is available.

Martin Denver
8 Hrs, 150, 156, 0.96, 1 Jan 60 to 30 May 60, 1 Mar 57, is not available.

North American
2 Hrs, 45.6, 46.5, 0.98, Jan 60 to Mar 60, Jan 57, time is available.

Attempted to run time does not include scheduled or unscheduled maintenance.

Pratt and Whitney
398, 410, 0.97, 1 Jan 59 to 31 Dec 59, 28 Jul 58, is not available.

Rand
4 Hrs, 80-85, 105, 0.785, 1 Jan 60 to 1 Jun 60, Mar 56, time is available.

Raytheon
Time is available.

Republic Aviation
100, 110, 0.90, Jan 60 to Mar 60, Oct 58, is not available.

Main operating malfunctions of the 704 center about the tape system.

Sandia
Attempted to run time 80 Hours/Week (Average)
Operating ratio 0.95
Passed Customer Acceptance Test Nov 58
Time is not available

Socony
70, 76, 0.92, 1 Apr 60 to 30 Apr 60, time is available to qualified organizations.

Standard Oil California
93.1, 95.1, 0.947, Feb 60 to Apr 60, Jul 57, time is available.

Standard Oil Indiana
61, 62, 0.984, 1 Jan 60 to 31 Aug 60, 1 Apr 60, time is available.

Outside organization use is 8.8% of total use per month.

Temco
5 Hrs, 55, 57, 0.964, 1 Jun 60 to 30 Jun 60, 4 Apr 60, time is available.

United Aircraft (3)
12 Hrs, 71.12, 77.82, 0.914, 1 Jan 60 to 31 Mar 60, Jun 57, time is available to qualified organizations.

Outside time depends upon work load and restricted to second and third shifts. Good time includes calculation, program testing, improvement of techniques and laboratory error. In addition to these, attempted to run time includes machine error, scheduled and unscheduled maintenance.

Chance Vought
74, 77, 0.96, Jan 59 to Dec 59, Aug 57, time is available.

Westinghouse Baltimore
38.65, 45, 0.859, Jan 60 to Jun 60, Sep 57, time is available to qualified organizations.

Westinghouse East Pittsburgh
4 Hrs, 78.3, 79.1, 0.99, 1 Jan 60 to 31 Mar 60.
Time is available for rent to qualified outside organizations during the evening if the load is light.

Cal Tech JPL
89, 90, 0.96, Jan 60 to May 60, 3 Oct 58, is not available.

MURA
52, 60, 0.87, Mar 59 to Apr 60, 7 Nov 56.
Time is available to other government sponsored work and other AEC work only.

TEES
Passed Customer Acceptance Test 9 Dec 59
Time is available for rent to outside organizations.

U of Cal Los Alamos
1800, 1900, 0.95, 56 to 60, 56, time is available to qualified organizations.
Data refers to 3 systems.

U of Cal Berkeley
155, 160, 0.96, 1 Dec 59 to 30 Apr 60, 1 Nov 59, time is available to qualified organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
Outstanding features are high speed, floating point, compatibility with 709 and 7090, and large core memory.

Recommended procedures for magnetic tape storing, shipping, and protection from humidity, temperature, electrical, fire, or other damage:

Acetate Base Tape:
Storage for frequent usage.
Relative humidity 40 to 60%
Temperature 65 to 80°F.
Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, the following specifications would apply:

Storage for infrequent usage.
Temperature 40 to 120°F.
The tape must be placed in a dust proof container and hermetically sealed in a plastic bag. Before re-using, the tape must be reconditioned by allowing it to remain in the conditioned atmosphere for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours.

5.02 Mylar Base Tape
Storage for frequent or infrequent usage.
Relative humidity 0 to 80%
Temperature 40 to 120°F.
The tape should be stored in a dust proof container. Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, it must be reconditioned by allowing it to remain at the given condition for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours.

The upper limit on humidity is given to prevent the formation of fungus and mold growth. This limit may be exceeded by hermetically sealing the tape in a plastic bag.

General Precautions:
The tape should not come in contact with magnetic material at any time and should never be subjected to strong magnetic fields. Either of these can cause the loss of information or the introduction of noise.

When shipping magnetic tape, the reel should be placed in a dust proof container and hermetically sealed in a plastic bag. Additional support should be obtained by enclosing in an individual cardboard box.

USA BMA (now NASA)
Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include the use of external labels (pressure adhesive) and tape cabinet storage in the computer room.

USA BMA (now NASA)
Outstanding features include the tape switching device.

USA WSMR CO
An outstanding feature is that jobs are run under an automonitor system. Also, operator motions are cut to a minimum, saving machine time and reducing the chance for operator errors. The machine is used more efficiently as all input-output is magnetic tape under this system.

Tapes are labeled under one of three categories, scratch tapes which are used for input and output, library tapes, and project tapes. Tapes are kept in plastic, dust free containers when not in use and are stored in metal tape cabinets. The tape cabinets are kept in a room where temperature and humidity are controlled.

USA WSMR
Unique system advantages are the SHARE Service Routines and Library.

Tape procedures:
Each tape is labeled with an adhesive marker with identification of its contents. Tapes are stored in a metal cabinet easily accessible. Cabinets are manufactured by Wright Line Inc., Worchester, Mass.

USN David Taylor
Outstanding feature is modification of a Remington Rand high-speed printer to accept IBM 704 tapes for print out.

USNOL White Oak
Tapes are stored in metal cabinets in the same controlled area as the computer.

USAF Eglin AFB

This 704 will handle the Sage Computer (FSQ-7) generated tape (32 bit word).

Adjacent to the computer is a vault for housing all tapes not in the data reduction cycle.

USAF Edwards AFB

An outstanding feature is internal accounting clock for timekeeping purposes.

Plastic tape containers are used to protect from humidity, temperature; metal containers are used for shipping. Locally reproduced forms are utilized for labeling.

USAF SAC Offutt

Each magnetic tape has been assigned a serial number in order to facilitate identification and control for processing and stripping purposes. Additional identification is accomplished by attaching paper labels to tape reels and, in some cases, by color coding tape reels or their containers.

The majority of tapes are retained either in the machine room proper or in adjacent areas of the SAC Underground Control Center, all of which are of permanent-type construction, and operated in accordance with normal electrical and fire preventive precautions. Machine room and other storage area temperature and humidity ranges have proven to be adequate for tape storage. All using personnel are instructed in proper tape-handling procedures. Smoking is not permitted in the machine room or other areas containing uncased tapes.

BFS FAA

Outstanding features are graph plotting device installed on the printer to print graphs using plus characters with 30 inch x 30 inch resolution. Three tape drives have ungapped read feature where a tape can be read with a two-word inter-record gap instead of conventional 3/4 inch inter-record gap.

Tape labelling - gum-backed paper label used. Storage - tapes are stored in computer room under controlled humidity and temperature. Shipping - shipped in specially designed cartons. Protection from humidity - shipped sealed in plastic bags. Temperature and physical - tape handling areas have controlled temperature. Physical damage is controlled by tale handling techniques. Electrical, fire, or other damage - plans are to protect master files in a specially constructed safe.

NASA Ames

Nothing is planned for protection against damage. Labelling is done on cards inserted in holder. We have a very small library.

NASA Lewis

Outstanding feature is open shop programming using "Fortran" compiler automatic operating system and the modified General Motors "Monitor" System.

TVA

TVA has a 16,384 word drumless 704 System. Modifications necessary to run programs written by other installations for machines with drums are made by an IBM applied science representative and a TVA systems programmer. An important program in this category is the FORTRAN compiler which is maintained by IBM for the 4,096 word, 8,192 word, or 32,768 word systems.

Tape librarian maintains all tapes, including labelling, assignment to jobs, and recording of tape assignments. Tapes stored in cabinets in the 704 room for humidity and temperature control. Copies of important master tapes maintained in another building as precaution against destruction of tapes held in 704 room. Temperature alarms and CO_2 fire extinguishers spaced around the 704 room.

Bell Tel Whippany

Outstanding features are Sage compatibility, Share standard system, J. B. Lewis Tape Switching Network, and Bell System input-output and monitor system.

For the protection of magnetic tape, standard 704 installation (manual) procedures are followed. The computer area is equipped with fire detection apparatus.

Bendix Systems

Outstanding features are READ DRUM Continuously, REAL TIME Package, and special store instructions for masking instructions.

Unique system advantages are that the above two items are used with the Bendix COED (Computer Operated Electronic Display) System for real-time alphanumeric and graphical presentation.

The IBM 704 at Bendix Systems Division has an unusual input/output device attached. This device, the BSD simulation tool (COED (Computer Operated Electronic Display), is used as a display and input output data device in obtaining design data and for evaluating systems employing a man/machine interface. The device is comprised of three basic units: the I/O discrete buffer, the drum buffer, and a DIGITRON display unit. The I/O discrete buffer performs input of program control commands by means of switches and a program interrupt feature, and receives outputs in the form of binary signals which are used to signal visual indicators. The drum buffer performs the control necessary to extract data from the IBM drum on a cycle basis for display on a DIGITRON cathode ray tube. The DIGITRON display unit manufactured by Marquardt Corp., decodes binary words and generates positional data, alphanumeric characters (64), and lines between any two specified points. This device in conjunction with the IBM 704 Computer may be used to develop design parameters in complex weapon display systems, air traffic control problems, radar displays, industrial control monitoring, and many other applications.

Magnetic tapes containing information to be saved are labelled with gummed paper labels on which the identifying information is written. Tapes not in use are always kept in plastic containers to prevent damage and to keep the tapes dirt free. These are stored in open tape racks in an air conditioned facility, to provide temperature and humidity control. No special provision is made for fire damage.

CEIR

Tapes are labelled with Labelon Plastic Tape. Tapes are shipped in special metal cases. Tapes are stored in humidity and temperature controlled rooms. Fire extinguishers are placed throughout machine room and tape library.

Convair Fort Worth

Magnetic tapes are labelled with insert cards, placed in plastic cans and stored in metal racks. They are stored in the computer area with continuous temperature and humidity control. The entire area is protected by heat sensors and a sprinkler system.

Convair San Diego

Outstanding features are direct tie with test facility area (2 miles) by direct phone line at magnetic tape speed - tape to tape.

Magnetic tape is kept in the same room as the 704 which is kept under air conditioned control at all times.

GE Evendale

Outstanding features are that machine has on line linkage to test cell to perform automatic test data reduction, machine is equipped with interruptability device permitting instantaneous processing of the data upon demand from the test site, and machine is

controlled by monitor system, so that the only time a human operator does anything to the machine configuration is when the program deviates from "standard". All directions for supplemental action are printed on-line.

Only operators handle tapes. Tapes are stored in plastic containers which are then kept in closed metal cabinets. Tapes are kept in constant temperature, constant humidity room.

GE Schenectady

Outstanding feature is the printer - 1,000 lines per minute with record select so that four reports can be intermixed on one tape. Unique system advantage is the speed of off-line printer, mixture of check-out and production runs in automatic system.

System is made up of a 704 with 10 tapes and 738 core. Off-line equipment includes one IBM card to tape reader and one 1,000 line a minute Anelex printer.

Tape handling procedures: Tape reels numbered. 5 part tape labels containing reel number and contents-1 on reel, 1 on case, 3 returned to customer. Tape storage room, humidity and temperature controls, fire protection-majority of tapes stored in separate room, open area in computer room, hand fire extinguishers.

GMC Warren

Outstanding feature is multi-job monitor that allows such things as FORTRAN compilation. SAP assembly along with immediate execution. IBM manual tape switching between 704 and peripheral equipment. General Motors programmable time clock is a unique system advantage.

Tapes are stored on numbered reels within metal cabinets located in the computer room.

GMC Indianapolis

All reels of magnetic tape contain as the first record a label consisting of the tape serial number, date written, description of data contained, and a purge date for the recorded date. Every program tests all tapes used for proper assignment of input and expired purge dates for output prior to processing. Working tapes are stored in the same temperature and humidity controlled area as the computer. Historical tapes are stored in a fireproof vault located in a plant approximately 1/2 mile from the computer building.

Grumman

A monitor (executive) system is being used to run approximately 75% of our current programs on the IBM 704. This system was GM "F" System. By this executive control program, tape is used exclusively for input/output operations and idle time between programs is held to a minimum.

At present a "Real Time Package" is being installed which will enable the computing facility (analog and digital) to actually combine hardware for solution of problems where this configuration shows real advantage.

Nothing unique has been adopted. We attempt to eliminate as much as possible tape difficulties, by conscientiously stripping our tapes at regular intervals and in this way our debugging operations seldom consider worn tapes.

Gulf

Special room for magnetic tapes, always air conditioned.

IBM PDL Poughkeepsie

All tape is stored in a fire-proof room in closed cabinets. This room being air-conditioned, sprinkled and under the supervision of a tape librarian. At appropriate intervals, master tapes are removed and stored in Vital Record Storage outside Poughkeepsie, New York.

IBM GPD DL Endicott

Outstanding features are half word arithmetic, half word logic, copy and add and carry, 12 sense switches, back space file, and tape validity check (717).

Tapes externally labelled, stored in metal tape racks in an air conditioned room with fire detection system.

IBM RC Yorktown Heights

Outstanding features are programmable accounting clock, backspace file, floating point trap, buttons used with MAD, and I/O indicator lights.

Tapes are numbered and then assigned. They are stored in fireproof cabinets in the machine room so that they are always at the temperature and humidity of the machine room.

Martin Denver

Tapes are identified by reel number and a job label, tape usage log is maintained for periodic trimming of tape. Tape cabinets are used for vertical storage of reels in sealed plastic container. No special caution found necessary for humidity or temperature effects other than normal computer room environment.

Pratt and Whitney

Outstanding features are universal tape selector used with the 704. Tape selector enables us to go from one job to the next in a minimum amount of time.

Republic Aviation

All tapes are labelled, scheduled retention of previous master files and activity files, duplicate master files, air conditioning, dust and humidity control.

Socony

This computer configuration conforms to the minimum requirements as established by the SHARE organization.

All tapes stored in computer room.

Standard Oil of California

Unique system advantages are the special instructions on machine: backspace file, floating point trap, copy and add logical. The system has a 32,768 word memory, 8 tape stations and magnetic drums.

Recommended are the IBM procedures in "Magnetic Etiquette" Form 570-0702.

Standard Oil Indiana

All tapes numbered, non-eraseable tapes have gummed labels attached. Storage of tapes is in computer room. High and low humidity and temperature control to cut off power. Fireproof building plus extinguishers and fire hoses.

United Aircraft (3)

Outstanding features are the universal tape selector, automatic logger system, and MAPT converter.

Unique system advantages are the ability to select tapes from the machine console, records accounting information on punched cards automatically, and system converts from magnetic tape to perforated paper tape with read back checking features.

Magnetic tape records in card form maintained. Tape racks and cabinets used for storage. No special shipping procedures. Tapes stored in metal cabinets in machine room which is air conditioned, humidity controlled, and contains a fire-detection system.

Chance Vought

A unique system advantage is the operating control system.

Tape handling procedures include label reel and store by fixed location, closed storage for tapes, and tapes are in air controlled room.

Bell Aero

Tapes are kept in plastic cans in steel cabinets. The storage room is kept at the same temperature and humidity as the computer room.

Westinghouse Baltimore

A unique system advantage is AUTOPSY (Automatic Multiple Problem Tape-to-Tape Operating System).

Each tape is identified by a small card. Tapes are kept in storage cabinets in the temperature and humidity controlled computer room. A study is being made to determine what kind of fire proof storage equipment will adequately protect tapes against major disasters.

U of Cal Los Alamos

Individuals have responsibility for tape labelling. Tapes are kept at same temperature and humidity as machines.

FUTURE PLANS

Manufacturer

The steps upward in capacity of computers from the 704 were to the 709 and 7090.

USA BMA (now NASA)

The 704-1 described has since been returned to IBM and in its place a 7090 System has been installed. A second 7090 System will replace the 709 Computer and the 704-2 will be returned to IBM. The present peripheral equipment, 720, 730 and controls, will be replaced by 1401 Data Handling Systems.

USA WSMR CO

Real time flight analysis run on a 7090 or comparable computer.

USN David Taylor

It is planned to turn this IBM 704 System in for an IBM 7090 System.

USNOL White Oak

Plan to install a Type 1401 Data Processing System. This will replace the present off-line equipment, (tape printer and card-to-tape converter).

USAF Eglin AFB

IBM 7090 Computer as a capacity replacement for the 704. Two channels, 14 Model IV Tape Drives, 32K core.

IBM 1401 Systems as a replacement for the 714, 720A and 774.

USAF Edwards AFB

It is anticipated to acquire a 720-721 System, High Speed Printer and Punch.

It is anticipated to acquire an IBM 7090 System which will consist of the following equipment: 7100 - 2 units, 7151, 7302, 7606, 7607 - 2 units, 7608, 7618, II 7617 - 2 units, IV 729 - 5 units, 711, 721, 716, 1401-C3, 1402, 1403, and II 729 - 7 units.

USAF SAC Offutt

The computer system described herein was established as an interim facility to support SAC needs pending development of a much more sophisticated and inclusive system specifically designed to support the SAC mission. The prime contractor for this system - designated as 465L, the Strategic Air Command Control System - is the International Electric Corporation, a subsidiary of International Telephone and Telegraph Corporation. The data processing subsystem of 465L, for which IBM is the sub-contractor, will contain multiple AN FSQ-31 Computers, now being developed, which either individually or collectively will have a much greater speed, capacity and scope then does the present system. It will be sometime, however, before the 465L System will have sufficiently developed to replace the 704 Computer System now in use.

USAF Kirtland AFB

Future workloads indicate a need for a faster machine. Future planning is for a transistorized high-speed electronic computer of the IBM 7090 class to replace the present system.

BFS FAA

We now have the Navaid Check and Evaluation System and the Intermediate Altitude Position Fix System.

A proposed system is the Basic Altitude System.

New components to be acquired are off-line tape-to-card, off-line card-to-tape, and a 1401 to replace other off-line units.

NASA Lewis

An IBM 1401 has been ordered. It will take over all off-line tasks and some on-line tasks connected with the 704 operation. Later some input-output service for the 1103 will be picked up. Also some payroll and inventory services.

TVA

Equipment on order consists of IBM 1401 Model C3, 1402, 1403 Model II, and 729 Model II (2). Equipment to be released upon receipt of above are the IBM 714, 717, 722, 759, 757, 758, and 727 (2).

Allis-Chalmers

Propose adding 6 tape units and a drum unit.

Propose installing an IBM 7090 within 2 years, and operating an integrating computing system.

AVCO

This system is being replaced in the next six months by a PHILCO Transac System.

Bell Tel Whippany

Three IBM 1401 Systems to replace off-line equipment.

Bell Tel Murray Hill

Plan to replace 704 by 7090, peripheral equipment by 1401's (3).

Bendix Systems

During the next year, consideration is being given to expansion from an 8,192 word core storage unit to a 32,768 word core storage unit.

CEIR

IBM 7090 to be in operation in Arlington, Virginia.

IBM 7090 to be in operation in New York, New York.

Convair Fort Worth

Proposed new equipment is as follows:

An IBM 1401 System to replace the peripheral equipment.

An IBM 7090 System to replace the 704.

Additional applications are constantly being programmed. The file of currently active programs for the IBM 704 consist of approximately 300 programs.

GE Evendale

Expect to get IBM 7090. Systems plans call for FAP/FORTRAN/SURGE to be basic compilers. Monitor system will handle communication problem.

GMC Warren

Replace the existing 704 and associated peripheral equipment with an IBM 7090 supported by IBM 1401 Systems to handle the input-output processing.

GMC Indianapolis

IBM 7090 System to be installed.

GMC Indianapolis

Present plans call for the cancellation of our 705 and 704 Systems and the acquisition of a 7090 System and three 1401 auxiliary systems. This computer system is to be shared by both the commercial and scientific parts of our organization. Because of the tremendous increase in speed of this computer we plan to convert two shifts of 705 operations and one shift of 704 operation into a combined one shift or less 7090 operation. Any expansion of present applications or the mechanization of new problems will, of course, not occur until we have approached a degree of computer efficiency that will justify additional shift rental costs.

Grumman

With the growth in the computing requirement for our Engineering Department occurring over the past 10 years, we expect to obtain in the near future greater

computing capacity to handle an increasing load. Therefore, newer high speed engineering computers are being evaluated for our needs. It is anticipated that a powerful computer would be complemented with smaller computing devices, which engineers could directly apply to small one-time problems.

Gulf

Proposed are an IBM 1401, an IBM 7090, and a magnetic tape transmission system.

IBM PDL Poughkeepsie

Our present 705 and 704 Systems will be replaced by 7080 and 7090 Systems.

Peripheral equipment will be replaced by 1401 Systems and systems operations will be oriented to tape input/output operation.

IBM GPD DL Endicott

Column binary modification for card to tape (off line) is being ordered for use with the FK MAD Monitor which requires column binary.

A 1401 System to be used as peripheral equipment for the 7090 has been ordered.

IBM San Jose

IBM 1401 System to be installed for peripheral usage, tape to punch, tape to printer, card to tape.

IBM 7090 System is to replace 704 System.

IBM RC Yorktown Heights

Planned replacement by IBM 7090 System.

Marquardt

Plan to put in operation a computer system program whereby FORTRAN programs may be compiled and/or executed and symbolic programs assembled from same input tape.

An IBM 1401 Tape System is scheduled for delivery. It will be used in support of the 704, replacing the present peripheral equipment.

An IBM 7090 System is being ordered.

Martin Denver

IBM 7090 to be installed as a replacement for the IBM 704.

Two IBM 1401's to be installed to replace present off-line equipment.

North American

We hope to increase our computer usage to the point where it would be profitable to get the IBM 7090. If our usage does not increase in a year or so, we will probably consider replacing the relatively-unreliable 704 with a less expensive reliable solid-state computer.

Pratt and Whitney

An IBM 7090 will replace the IBM 704. Two IBM 1401 Systems are on order. The first is to be used as 7090 peripheral equipment, and the second is to be used for commercial applications. FAP-FORTRAN system will be used on the 7090 with modifications to make off-line operation more efficient.

Rand

An IBM 7090 is to be delivered.

Republic Aviation

Column binary will be added to 704 peripheral equipment to allow for program read in on tape.

The 704 System will be replaced by a 7090 System. The 7090 will include a 32,768 core storage, 12 on-line tapes and peripheral tape to printer, tape to card and card to tape.

The 7090 peripheral equipment will be replaced by IBM 1401 Systems - as soon as avilable, including two 600 lines/min printers.

Sandia

Current trends indicate the need of a larger system.

Socony

An IBM 7090 will be installed and the 704 will be returned.

Standard Oil of California

Propose to replace IBM 704 with IBM 7090 and 1401 series computers. Company's home office machine accounting groups will be consolidated with the Computer Center with acquisition of the 7090-1401 System.

Standard Oil Indiana

To be obtained are the 717 Printer, 714 Card Reader, 727 Tape, 727 Tape, 757 Printer Control, 759 Card Reader Control; and Tape to Card 1401.

United Aircraft

Philco 2000 System will be installed. This system will replace one (and possibly two) IBM 704 Systems. Thereafter a second Philco 2000 System will be installed. At that time all three (3) IBM 704 Systems will have been replaced.

The second system will be the central data processor for System 433L. This system will be modified to permit communication directly with high-speed communications circuits and with various government-furnished external devices.

A high speed printer-plotter, operating from magnetic tape, will be in operation.

A magnetic tape to magnetic tape conversion system is expected to be in operation. This system will enable the Philco 2000 Computer to use data prepared on an IBM 704 Computer.

Westinghouse East Pittsburgh

An IBM 7090 is to be installed.

Cal Tech JPL

IBM will deliver a 7090 Type EDPM with 10 tape units. Subsequently, a 1401 Type EDPM will be installed to handle off-line I/O in addition to some small amount of data processing.

It is planned to provide some form of direct data input to the 7090, but as of this date, no proposals have been officially formulated.

MURA

IBM 1401 System to be delivered.

TEES

The 704 will be replaced with a 32K, 2 channel, 8 tape IBM 709.

U of Cal Los Alamos

STRETCH System is due for arrival in 1961. A new building is being built to house it.

U of Mich

Expansion to a larger scientific computer.

INSTALLATIONS

U. S. Army Ballistic Missile Agency, Computation Laboratory, Redstone Arsenal, Alabama (now NASA)(2)

U. S. Army White Sands Missile Range, Control Office, Ordnance Mission, White Sands Missile Range, New Mexico

U. S. Army White Sands Missile Range, Integrated Range Mission-DRD, White Sands Missile Range, New Mexico

U. S. Navy David Taylor Model Basin, Applied Mathematics Laboratory, Washington 7, D. C.

U. S. Navy Ordnance Laboratory, White Oak, Silver Spring, Maryland

U. S. Air Force Mathematical Services Laboratory, Computer Operations Branch, APGC (PGVMC), Eglin Air Force Base, Florida

U. S. Air Force Flight Test Center, Data Processing and Computing Branch, Edwards Air Force Base, California

U. S. Air Force, Headquarters, Strategic Air Command, Offutt Air Force Base, Nebraska

U. S. Air Force SWWVD, Headquarters, 4925th Test Group (Atomic), Kirtland Air Force Base, New Mexico

Argonne National Laboratory, Box 299, Lemont, Illinois

Federal Aviation Agency, Bureau of Flight Standards, Aircraft Management Division, P. O. Box 1082, Oklahoma City, Oklahoma

National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California

National Aeronautics and Space Administration, Lewis Research Center, 21000 Brookpark Road, Cleveland 35, Ohio

National Bureau of Standards, Connecticut and Van Ness Street, N. W., Washington, D. C.

National Security Agency, Ft. George G. Meade, Maryland

Tennessee Valley Authority, Computing Center, 116 Old Post Office, Chattanooga, Tennessee

Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin

AVCO Corporation, Research & Advanced Development Division, 201 Lowell St., Wilmington, Mass.

Bell Aerosystems Company, P. O. Box 1, Buffalo 5, New York

Bell Telephone Laboratories, Whippany Road, Whippany, New Jersey

Bell Telephone Laboratories, Murray Hill, New Jersey

The Bendix Corporation, Bendix Systems Division, 3300 Plymouth Road, Ann Arbor, Michigan

C-E-I-R, Incorporated, 1200 Jefferson Davis Highway, Arlington 2, Virginia

Convair, Fort Worth Division of General Dynamics Corporation, Fort Worth, Texas

Cornell Aeronautical Laboratory, Incorporated, 4455 Genesee Street, Buffalo 21, New York

Convair-San Diego, Plant I, Building 54A, Pacific Highway, San Diego, California

Douglas Aircraft Company, Department G-318, 3000 Ocean Park Blvd., Santa Monica, California

General Electric Company, Black Canyon Highway, Phoenix, Arizona

General Electric Company, Evendale Computations Operation, Building 305, Evendale 15, Ohio

General Electric Company, Computer Systems and Operations, Schenectady, New York

General Motors Corporation, General Motors Technical Center, 12 Mile & Mount Roads, Warren, Michigan

General Motors Corporation, Allison Division, Plant No. 8, Indianapolis 6, Indiana

Grumman Aircraft Engineering Corporation, Engineering Department, Research Section, Bethpage, New York

Gulf Research & Development Company, P. O. Drawer 2038, Pittsburgh 30, Pennsylvania

IBM Corporation, Product Development Laboratory, High Street, Poughkeepsie, New York

GPD Development Laboratory, IBM Dept., 284, Endicott, New York

The Service Bureau Corporation, IBM Plant, Bldg. 10, Monterey & Cottle Roads, San Jose, California

IBM Research Center, P.O. Box 218, Yorktown Heights, New York

Lockheed Aircraft Corporation, Marietta, Georgia

The Marquardt Corporation, 16555 Saticoy Street, Van Nuys, California

Martin Company, Box 179, Denver, Colorado

North American Aviation, Incorporated, 4300 East Fifth Avenue, Columbus 6, Ohio

Pratt & Whitney Aircraft, Florida Research & Development Center, United, Florida

Rand Corporation, 1700 Main Street, Santa Monica, California

Raytheon Company, Missile Systems Division, Applied Math Section, Bedford, Massachusetts

Republic Aviation Corporation, Farmingdale, N. Y.

Sandia Corporation, Department 5240, Box No. 5800, Albuquerque, New Mexico

Socony Mobil Oil Company, Inc., 150 East 42nd St., New York 17, New York

Standard Oil Company of California, Electronic Computing Center, 225 Bush St., San Francisco, Calif.

Standard Oil Company of Indiana, 2400 New York Avenue, Whiting, Indiana

Temco Electronics & Missiles Company, P.O. Box 6191, Dallas, Texas

United Aircraft Corporation, Research Laboratories, 400 Main Street, East Hartford 8, Connecticut (3)

Chance Vought Aircraft, Incorporated, Dallas, Texas

Westinghouse Electric Corporation, Air Arm Division, Box 746, Baltimore 3, Maryland

Westinghouse Electric Corporation, 4L39, East Pittsburgh, Pennsylvania

California Institute of Technology, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena 3, Calif.

Midwestern Universities Research Association, 2203 University Avenue, Madison 5, Wisconsin

Ohio State University, Columbus, Ohio

Texas Engineering Experiment Station, Data Processing Center, College Station, Texas

University of California, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, New Mexico

University of California, Computer Center, 201 Campbell Hall, Berkeley, California

University of Michigan, Computing Center, Ann Arbor, Michigan

Washignton State University, Pullman, Washington

U. S. Navy Mine Defense Laboratory, Panama City, Florida (Anticipated)

U. S. Navy Underwater Sound Laboratory, New Haven, Connecticut

IBM 705 I II

IBM 705 Model I and II Electronic Data Processing Machine

MANUFACTURER

International Business Machines Corporation

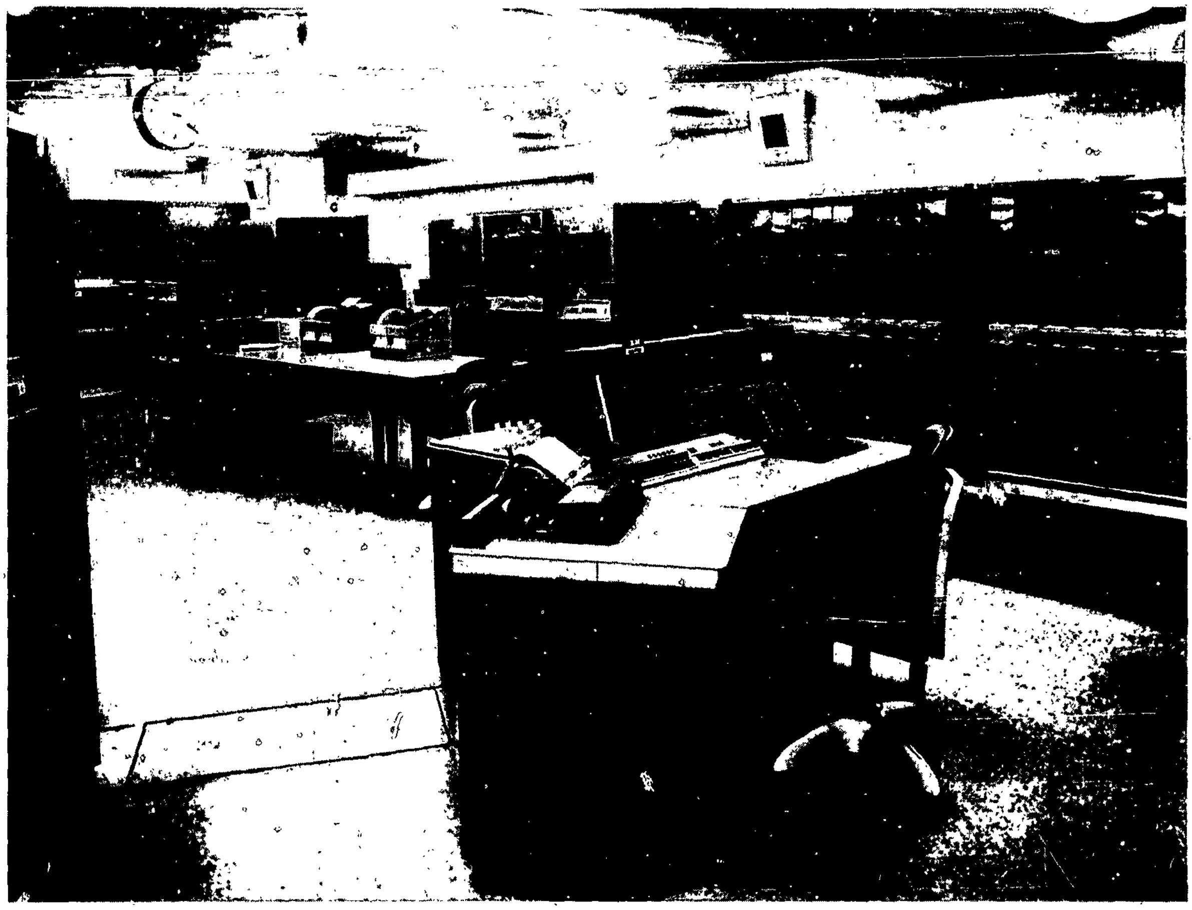


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer
For commercial applications with some scientific applications - engineering design, manufacturing and inventory control, cost and financial control, billing, actuarial work and sales reporting.

U. S. Navy Construction Battalion Center
Located at Port Hueneme, California, the system is used for Navy-wide facilities inventory (Class I and II Real Property), fiscal accounting, payroll and personnel accounting, shop stores inventory accounting, supply demand control point applications, and the BuDocks Functional Component Program.

U. S. Navy Mare Island Shipyard
Located in the Management Engineering Office at Mare Island, the system is used for funds control, production control, payroll, leave and bond accounting, cost accounting, equipment maintenance control, transportation maintenance control, radiac equipment maintenance scheduling and control, supply inventory control, shop store inventory control, direct purchase material control, material availability reporting, scientific and engineering problems, and commitment accounting.

U. S. Army The Adjutant General's Office
Located at BE 838 The Pentagon Building, Washington 25, D. C., the system is used for military personnel accounting, civilian personnel accounting, and organizational accounting.

U. S. Army Ballistic Missile Agency
Located at the Redstone Arsenal, Alabama, the system is used for commercial applications only viz., national supply management and stock control, program budget control, financial and inventory supply accounting, and engineering documentation.

U. S. Army Engineer Maintenance Center
Located at 52 Starling Street, Columbus, Ohio, the system is used for inventory control and document processing, financial inventory accounting, requirements forecasting, repair parts budget estimates, mobilization reserve materiel requirements, and annual

Photo by U. S. Army Photo Agency, TAGO

tabulations of demands and inventory groupings by dollar value.

USAF Hq OCAMA, Tinker AFB

Located at Tinker AFB, Oklahoma, the two systems are used for requirements computation for consumption type items - system develops wearout rate factors and computes consumption type item spare parts through application of projected AF programs to AF assets in order to provide a means for determining procurement actions and budget estimates, contract termination, disposal action, overhaul, etc.

Air vehicle configuration - system provides a central point the necessary records for all of a specific type, model and series of air vehicle which permits the ready evaluation of each air vehicle's capability to perform specific missions and enables the logistic managers to project depot and contractual maintenance requirements; schedule air vehicles into modification and maintenance facilities; establish and evaluate future modernization maintenance funding requirements; and effect more economical procurement of kits and support parts. Provides rapid feedback of consolidated data to operating commands.

Weapons system stock control and distribution - similar to the commodity class property accounting application expanded to automatic distribution functions which include direct processing of debit, credit and file maintenance actions without manual action determination. Other than this the basic difference is the fact that master item records are established for items related to the weapon, rather than for specific commodity classes.

Propulsion Unit logistics system - system encompasses data for use in transportation management, material deficiency reporting and accounting, centralized inventory and distribution control, actuarial development, configuration accounting, consolidated requirements, etc. for AF engines.

U. S. Air Force Aviation Supply Office

Located at the Aviation Supply Office, Philadelphia, Pa., the system is used for inventory control.

U. S. Air Force Headquarters Air Defense Command

Located in Building S-3, Ent AFB, Colorado Springs, Colorado, the system is used for:

Military Personnel Accounting System

Application: Maintains the master military personnel file by editing, zero balancing, furnishes intra-command gain and loss information from changes submitted by sub-commands. Information maintained includes skill identification, grade, location, retainability or status, and similar data requirements necessary for the effective management of military personnel resources. Errors discovered through editing are coded and returned to the applicable sub-command. File maintenance is performed on a daily basis. Accomplishing these applications on EDPM increases accuracy, speed, and reduces workload at sub-command level.

Uses: Furnishes this and higher headquarters with

Photo by U. S. Army Engineer Maintenance Center

the most current personal data for all military personnel assigned. Information stored also furnishes data for the preparation and submission of 26 RCS reports.

Centralized Manpower Authorization System

Application: Maintains the unit manning documents containing detail unit authorizations for 17 projected quarters by processing into the master field changes from each unit and editing change cards for accuracy.

Uses: Information contained in the master file furnishes data for the preparation and submission of 9 RCS reports to higher headquarters. Various types of management reports are also prepared from this system. Information furnished is used for indicating authorizations for manning purposes and analysis; future planning and programming actions; authorized military strength by unit; manning assistance. For this system authorization documents are prepared and forwarded to subordinate units.

Unit Authorization List System

Application: Maintains an accurate and timely unit authorization list from changes processed into the master file.

Uses: Provides data at all echelons of command reflecting the status of UAL equipment for each organization assigned. Preparation of unit and materiel readiness authorization lists, analysis of organizational equipment, cost utilization as well as related management studies and reports.

Motor Vehicle Reporting System

Application: Maintains accurate and timely information on all vehicles assigned this command. Approximately 300 changes per week are applied to the master file.

Uses: Provides data to this and higher headquarters reflecting the status and condition of motor vehicles assigned this command. This system controls world-wide Air Force assets of all registered vehicles as defined in current AF regulations. All registered vehicles which are carried on any type of property record are accounted for by all active and reserve Air Force organizations. This system provides management with status, mileage, scheduled, and unscheduled maintenance. Labor and materiel repair costs are provided to obtain labor utilization, job performance, and job standards. From this data budget estimates are provided for management purposes.

Medical Stock Status Reporting System

Application: Maintains medical stock status for each base in this command. Approximately 120,000 detail records are created from this reporting system.

Uses: Provides a source for retail medical item requirement data, promote the maintenance of optimum base inventory levels, assist in the disposition and lateral distribution of long supply items.

Inventory of Existing Facilities System

Application: Maintains accurate and timely data for all existing real property facilities under control of this command. 29,000 records are contained

Photo by U. S. Navy Civil Engineering Laboratory

in the master file with approximately 10,000 changes per quarter processed.

Uses: Provides data indicating all types of facilities, what they are, and approximate value of each.

Civilian Personnel Services Cost Analysis System

Application: Maintains information providing for an analysis of basic and total obligations, quarterly and accumulative for Object Class 01, with a breakdown by lump sum payments, deductions and other variables. Information covers all categories of employees reflecting overall and basic salaries, man years consumed and percentage breakdown of variables to basic obligations. Master summary file amounts to 6,000 records with approximately 5,000 changes applied quarterly.

Uses: Furnish experience data to Hq USAF and this headquarters for the preparation of initial and revised financial plans and budget estimates. Provides information pertaining to skills, grade, salary, location, category and other similar data necessary for the effective management of civilian personnel resources. Prepares recurring or special reports relating to civilian personnel management.

Leased Communications Systems

Application: Maintains information furnishing detailed descriptions of services being ordered, i.e., interexchange channels, local channels and equipments with associated recurring non-recurring, minimum service and contingent termination changes.

Uses: Information stored is used in the preparation of contracts, budgets, establishment of accounts payable, posting of accounting reports and preparation of special reports as desired by this or higher headquarters.

Radar Evaluation Reporting System

Application: Master file contains information reflecting down-time of radar sites determined by their length of time, frequency and type of cause. 4,000 records are maintained with approximately 1200 changes per month processed.

Uses: Reflects equipment reliability and maintainability data, predictions of current month's unknown radar tracks.

Raid Recognition System

Application: By using the previous 6 months of unknown tracking information, data maintained reflects expected unknowns (by weight factor) for each 2 hour period of a day. Master file contains one record (273 characters in length) reflecting 6 months distribution of unknown tracks. Approximately 750 changes per month are summarized.

Uses: Assists in raid recognition.

Command Vehicle Management and Control System

Application: By utilizing the UAL master file, motor vehicle master file, and family grouping file, a report is created reflecting, by family grouping, the ADC command status of the motor vehicle fleet. Master file contains 10,000 records.

Uses: Provides the Vehicle Branch, D/Materiel, this Hq and AMC with Vehicle Management and Control Data.

USAF San Bernardino Air Materiel Area, AMC

Located at SBAMA, Norton AFB, California, the system is used for:

Advanced Weapons Support (IOCII)

This application consists of a functionally integrated logistic data processing system embodying methodologies and procedures which facilitate the operation of a logistical "pressure" system as contrasted to the traditional logistical demand system. This system includes such procedural concepts as central accountable records of all stock available to the weapons system, both wholesale and retail automatic

Photo by U. S. Navy Mare Island Naval Shipyard

resupply of material, central computation of net weapons systems requirements, etc. It includes inventory control, due-in assets, inventory accounting monetary, stock level computation, voucher computation, transportation scheduling, configuration accounting, program preparation and file maintenance of all records in the various segments of the system.

Requirements Computation

This system is designed to compute consumption type items spare parts requirements through the application of projected Air Force programs to Air Force assets. Replacement and wear-out factors are computed from consumption experience. This project encompasses all phases of the Air Force world-wide supply requirements system. In addition, it produces products which are analytical of supply effectiveness.

Due-in Assets

This project covers management and control of the Due-in Assets Procurement Records functions. It encompasses items due in through Procurement from contractors.

Product Improvement Program (PIP)

This program is a series of runs designed to accumulate the number of failures by work unit code (work unit code identifies a functional unit, not a specific part number.) When the number of failures exceeds tolerable limits, a report is prepared. At the end of the month any records which are below tolerable limits are also included in the report. An additional monthly product is a special report on the 10 systems with the highest number of failures and the 5 highest sub-systems within each system.

USAF Hq MAAMA Olmsted Air Force Base, Penna.

Located in Building 33, Bay A, the system is used for:

Requirements Computation for Consumption Type Items

All phases of the AF world-wide supply requirements system are encompassed in this application. Procurement actions, budget estimates, contract terminations, disposal action, overhaul, etc., are some of the programs that are determined. AF assets related to AF programs are computed thru development of wear-out rate factors. Management is provided the tools to establish standards and to measure the supply accomplishments.

Due-In Assets

This application encompasses records that are maintained to control materiel assets due in from contractual sources, intra-AF Depot transactions, acquisition from other federal departments and agencies, and contract termination inventories. Data are provided in the by-products to reflect quantity status of items in pre-contract and post-contract stages, delivery schedules, current status of deliveries, intransit balances (i.e., depot, Hi-Valu, GSSF depot/base), dollar value of both deliveries made and undelivered balances, and item data related to budget projects.

Requirements Computation for Replacement Type Items

The purpose of this application is to design, develop and implement a data flow and data processing system by which various types of replacement type item data products may be periodically computed on an AF world-wide basis. Data by-products from this system are projection of gross and net item requirements, procurement and budget estimate item and/or dollar summaries of the above mentioned requirements, contract termination and retention disposal level data, consolidated asset and item information data summary products, item-dollar inventory segmentation, and requirements support effectiveness data. This system is designed to promptly react to the elements which effect AF item requirements i.e., program

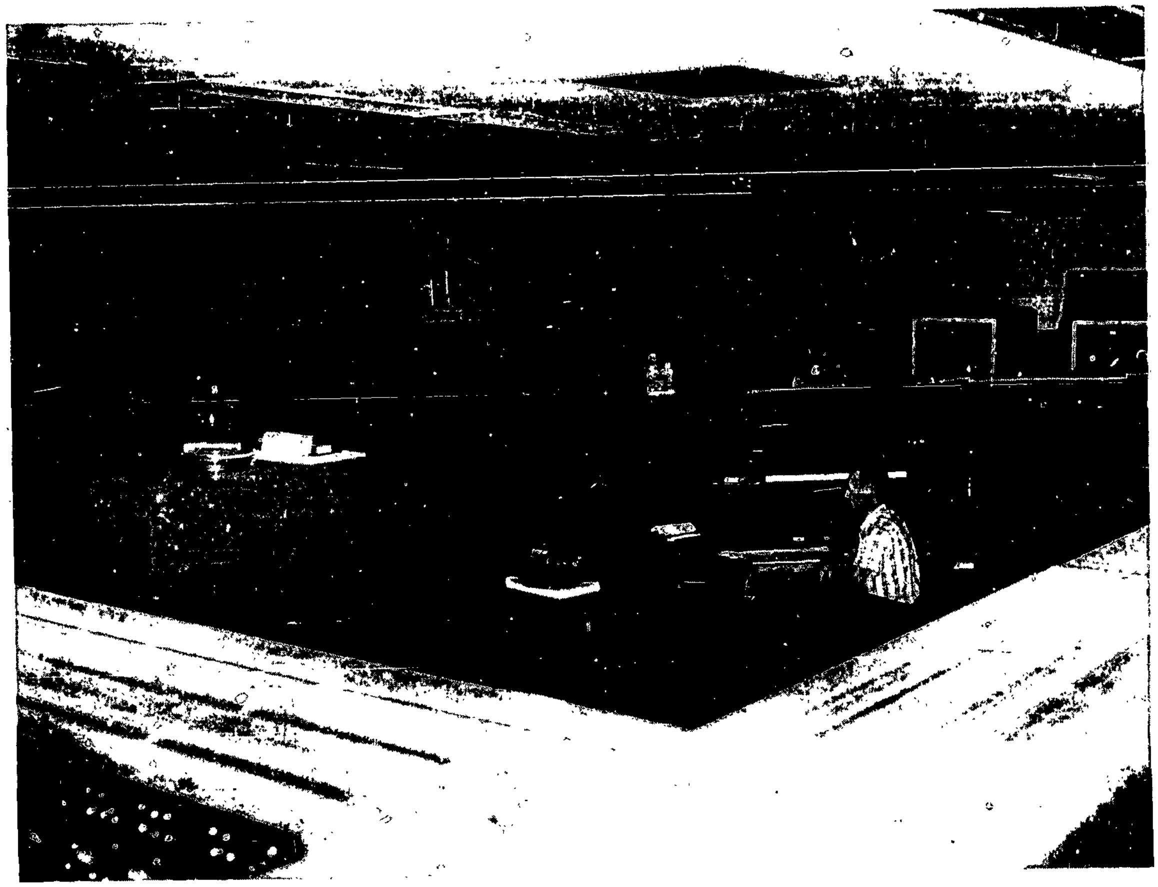


Photo by U. S. Air Force Mobile Air Materiel Area

changes, authorization changes, support policy changes, funding limitations, in order to be compatible with the latest data handling and processing technological improvements.

National Security Agency
Located at Ft. George G. Meade, Maryland, the system is used for data processing.

Amer. Tel. & Tel. Co., Long Lines Dept.
Located at Mt. Kisco, N. Y., the system is used for circuit provision, traffic load studies, accounting for operating and construction activities, message analyses (by mid 1960), pricing and billing private line customers (by late 1960), and plant trouble results - message circuits.

American Telephone & Telegraph Co., Treasury Dept.
Located at 50 Varick Street, New York, N. Y., the system is used for the processing of all records coincident with AT&T shareowners, such as maintaining the stock book, preparation of dividend payments, proxies, mailings, etc., shareowner statistics, reconciliation of dividend's and tallying of proxies, preparation of Federal and State Information Returns, and handling financing such as bond and stock issues.

Consolidated Edison Co. of N. Y., Inc.
Located at 4 Irving Place, New York 3, N. Y., the system is used for customer accounting, payroll, inventory control, stores accounting, preferred stock dividend accounting, and minor engineering studies.

Convair - A Division of General Dynamics Corp.
Located in the Industrial Accounting Department, Electronic Data Processing Section, at Fort Worth, Tex., the system is used for payroll and personnel, detail labor proration and parts cost, engineering parts list, planning parts list, fabrication work-in-process, production ordering and inventory control, spares inventory control, spares delivery surveillance. It will also be used for material inventory control, fabrication budget and status control, fabrication forecasts, fabrication machine utilization and quality control, engineering and planning configuration control, cost ledger, tool control, and summary production status.

Esso Standard, Div. of Humble Oil & Refining Co.
Located at the Refinery Main Office, Baton Rouge, La., the system is used for payroll, manpower scheduling, personnel statistics, sales scheduling, sales invoicing, sales statistics, storehouse stock control, purchase ordering, accounts payable, fixed asset accounting, financial accounting, financial reporting, cost accounting and reporting, crude oil and product inventories, refinery unit operating reports, equipment history records, technical and scientific computing, refinery simulation, and economic studies.

In addition to the 705 we lease an IBM 650 Basic Card Computer, which is used entirely on technical and scientific computing. This work is being transferred to the 705, and we plan to release the 650 this year.

Photo by U. S. Air Force Aviation Supply Office

We also have two Royal-McBee LGP 30 Computers, which are used exclusively for calculation of optimum blending of gasolines and other fuel products.

Farmers Insurance Group
Located at 4680 Wilshire Blvd., Los Angeles, Calif., the system is used for premiums-in-force file maint., premium billing, commission statements to agent, sales analysis, payroll, loss reserves, statistical analysis, and accounting data.

The Firestone Tire & Rubber Company
Located in Akron, Ohio, the system is used for sales analysis, payroll, inventory control, retail accounting, scientific computing, multiple correlations and simultaneous equations.

Ford Motor Company, Computer Services Dept., Manufacturing Services
Located in Room 1109, Rouge Office Building, Dearborn, Michigan, the system is used for 6,500 hourly payroll weekly, 30,000 salary payroll semi-monthly, 250,000 stockholders record accounting, general stores non-productive inventory control, Ford Motor Credit Company, salary stock investment program, and pre-production control, including bill of material, parts specification files, and engineering progress changes.

Ford Division of Ford Motor Company
Located at Ford Division General Office, Rotunda & Southfield, Dearborn, Michigan, the system is used for inventory control of service parts for 24 parts depots, production schedule, parts requirements and preparation of purchase orders to suppliers.

Hughes Aircraft Company, Industrial Dynamics
Located at Building 105, 5405 West 102nd Street, Los Angeles, California, the system is used for payroll and personnel reporting, company labor distribution, company material distribution, accounts payable distribution, purchase order distribution, material standard cost master, cost of sales reporting, company and government property accounting, expense and budget variance ledgers, analysis of engineering change costs, management engineering project status reporting, engineering costs detail ledger, cost plus fixed fees accounting and ledgers, fabrication work in progress ledgers, line flow work in progress ledgers, maintenance of manufactured parts list, maintenance of assembly parts list, provisioning maintenance parts list, and manufactured inventory control.

Hughes Aircraft Company, Industrial Dynamics
Located at IBM Service Bureau Corporation, 2706 Wilshire Blvd., Los Angeles, California, the system is used for the same applications as listed above.

International Harvester Company
Located at 1301 West 22nd Street, Broadview, Illinois, the system is used for processing weekly payrolls for 6 manufacturing plants, daily invoicing and stock status for 12 service parts depots, materials spreads for 7 manufacturing plants, cost and inventory accounting work for 7 manufacturing plants, engineering and technical problems.

Photo by U. S. Department of Health, Education and Welfare

Illinois Central Railroad Company
Located at 6327 South Dorchester Ave., Chicago 37, Ill., the system is used for all phases of railroad accounting work, including disbursement accounting, freight accounting, car accounting, and passenger and station accounting.

McDonnell Aircraft Corporation
Located on the 1st level of Administration Building (Main Plant), St. Louis, Missouri, the system is used for payroll and labor distribution, inventory and material accounting, accounts payable, financial forecasting, material requirements, parts list, work order release, manufacturing scheduling, parts control, shop load, spare parts processing, vacation schedules, rate reviews, personnel record keeping, and maintenance engineering and support.

Minnesota Mining and Manufacturing Company
Located at the Main Office, 900 Bush Avenue, St. Paul 6, Minnesota, the system is used for payroll, sales statistics, inventory control, billing, property accounting, distribution of expense, production, and applied mathematics.

Sandia Corporation, Electronic Data Processing Dept. 3450
Located at the Sandia Corporation, Sandia Base, Albuquerque, New Mexico, the system is used for payroll (pay 7,000 employees. Prepare all necessary reports), stores control (12,000 item inventory. Prepares all stockkeeping records. Determines replenishment requirements from usage activities and prepares purchase orders), quality assurance (analyzes product inspection reports and prepares various analytical reports), program planning (this is essentially a production scheduling job), and production control (includes production inventory control, material requirements analyses, and production shop scheduling). The Data Center does generalized statistical analyses routines, e.g. X Bar R process control charts, histograms, normal and cumulative, simple regression, multiple regression, and curve fitting.

The Standard Oil Company (Ohio)
Located at 717 Republic Building, Cleveland 15, Ohio, the system is used for invoice audit, sales accounting, sales statistics, wholesale accounts receivable, merchandise control, refinery stores accounting, refinery simulation, pipeline simulation, linear programming, and regression analysis.

Texaco Incorporated
Located in the Texaco Bldg., Houston, Texas, the system is used for accounting, technical and research applications. The accounting applications are integrated crude oil, integrated gas and gasoline, wholesale marketing, payroll, supply, and distribution. The technical and research applications are producing geophysical, petroleum engineering, civil engineering, refinery simulation, crude evaluations, plant process studies, pipe stress analysis, and determination of maximum allowable operating pressures. Calculations related to crude stills, fractionation, absorption and stripping are also performed.

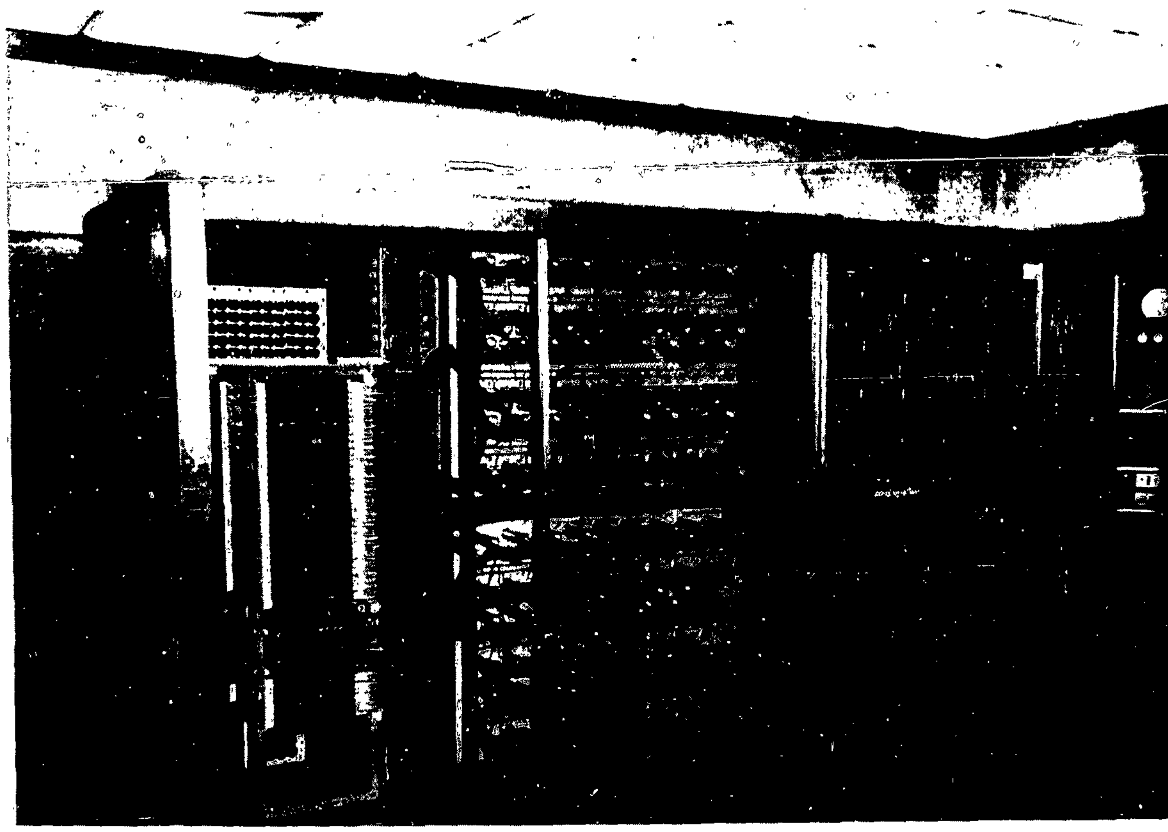


Photo by U. S. Department of Health, Education and Welfare

United States Steel Corporation
Tennessee Coal & Iron Division
Located in the General Office, Tennessee Coal & Iron Division, Fairfield, Alabama, the system is used for wage payrolls, calculation of incentive production performances for wage payroll, standard cost accounting system, stores inventory and accounting, and engineering and scientific problems.

Western Electric Co., Inc. Hawthorne Works
Located at Hawthorne Station, Chicago, Illinois, the system is used for payrolls, production and inventory control systems, cable running lists, merchandise stock inventory control, accounting, preparation of equipment engineering specifications, quality control reports, sales analyses, and miscellaneous reports.

Western Electric Co., Inc., Computer Methods
Located at 100 Central Avenue, Kearny, N. J., the system is used for the hourly rated payroll (payroll computation and compilation, deduction accumulations, and remittances. Federal and state payroll tax computation, recording and reporting), monthly rated payroll, wage incentive reports, labor distribution, preparation of engineered equipment job specifications, distribution of engineering time charges, and standard cost bulletin preparation.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system Binary Coded Alphanumeric
Binary coded alphanumeric char/word

The 705 is not a fixed word length system. It is possible to have both variable field and variable record lengths. There are no words, each character of a record being individually addressable.

Binary coded alphanumeric char/instruction 5
Instructions decoded 35
Arithmetic system Fixed point
Floating point is programmable.
Instruction type One address
Number range plus or minus 256 decimal digits
Instruction word format

X	X	X	X	X
Operation	Address			

Automatic built-in subroutines include store for print and transmit.

Automatic coding

Fortran (Automatic Formula Translation).

This is a program which allows expression of scientific problems in terms of mathematical formulae, with the formulae completely acceptable to the system. There is flexibility in the program allowing for expansion of the language and provision for inclusion of a library of programs previously written.

Photo by Convair Fort Worth

Autocoder

This program offers advantages of symbolic (step-by-step) coding and high level (multiple step) coding. Autocoder has macro-instructions by which means it is possible to generate many steps from one program instruction written in words close to english language.

Print I

This is an interpretive system which simulates floating decimal arithmetic circuitry as well as provide an internal library of mathematical functions.

Registers and B-boxes include a one 256 character accumulator, fourteen 16 character auxiliary storage units, and one 32 character auxiliary storage unit.

Construction (Arithmetic unit only)

Vacuum tubes	1,700
Transistors	0
Diodes	4,600
Magnetic cores	3,500

Figures are approximate.

Arithmetic mode	Serial	
Timing	Synchronous	Internal
	Asynchronous	I/O Area
Operation	Sequential	Internal
	Concurrent	I/O Area

Simultaneous reading and writing of magnetic tape units is possible.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	17 per digit

Multiply time = $17 \; |N_p(N_c+4) + 2|$ microseconds

N_p = No. of digits in multiplier

N_c = No. of digits in multiplicand storage

Divide time = $17|11+N_d+(N_d-N_r)(7.5\ N_r+15)|$ microsec.

N_d = No. of digits in dividend

N_r = No. of digits in divisor

STORAGE

Manufacturer

Media		No. of Char	Access Microsec
Magnetic Core	Model 1	20,000	17
	Model 2	40,000	
Magnetic Drum		60,000	8,000

The drum is arranged in 300 bands of 200 char/band.

Magnetic Tape 10,000

No. of units that can be connected	10 Units
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Char/sec

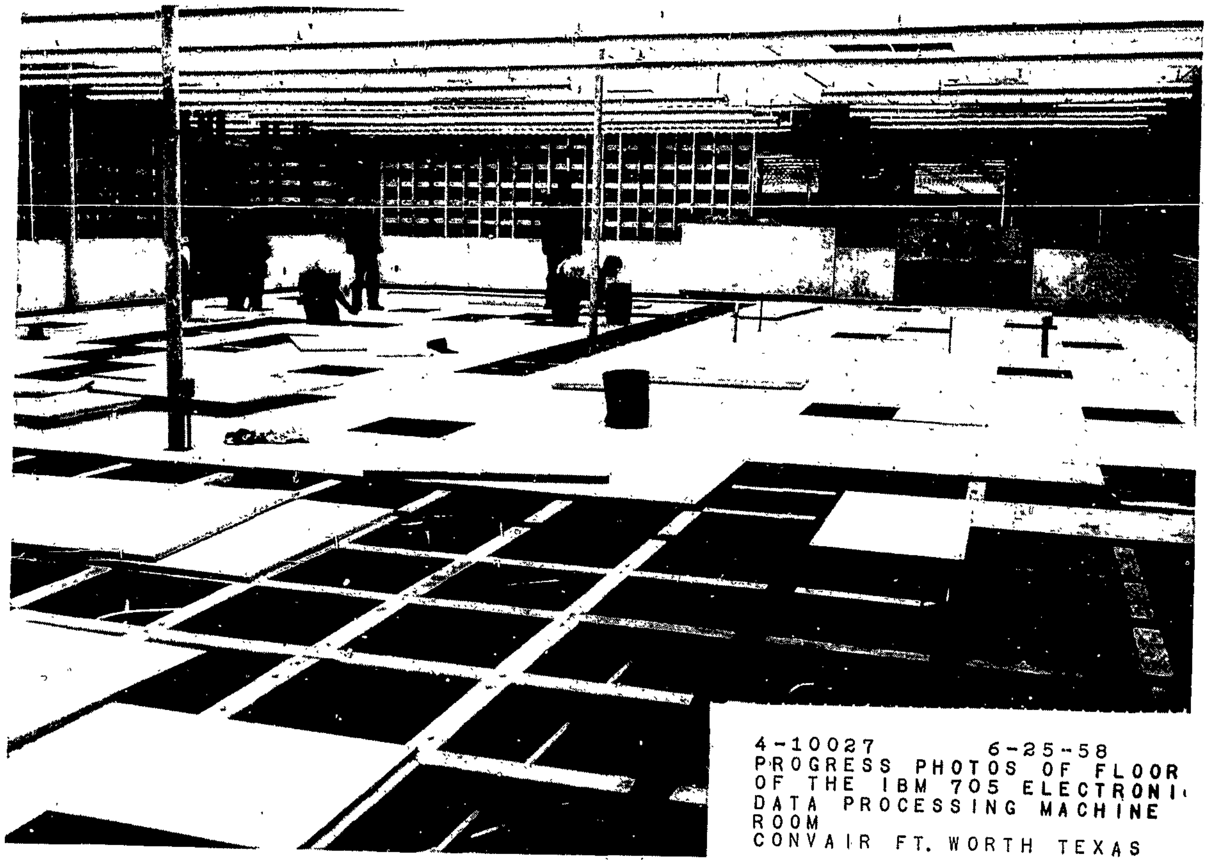


Photo by Convair Fort Worth

Start time	10 Millisec
Stop time	10 Millisec
Average time for experienced operator to change reel	Less than 60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	up to 2,400 Feet
Composition	Acetate or mylar

Mylar is DuPont's trademark for its polyester film.

Naval Construction Bn Ctr
Magnetic Core memory 20,000 characters; Magnetic Tape
An additional 512 positions of auxiliary storage are available. These serve as accumulators as well as storage positions.

Mare Island Naval Shipyard
Magnetic Core 40,000 characters; Magnetic Tape

USA TAGO
MC 40,000; MT

USA ABMA
MC 40,000; MT

USA EMC
MC 40,000; MT

USAF Tinker AFB
MC 40,000; Magnetic Drum 60,000 char

USAF ASO
MC 40,000; MD 60,000; MT

USAF ADC
MC 40,000; MT

USAF SB AMA
MC 40,000; MD 120,000; MT

USAF Olmsted AFB
MC 40,000; MD 60,000; MT

NSA
MC 20,000; MT

AT and T, LLD
MC 40,000; MD 60,000; MT

AT and T, TD
MC 40,000; MT

Boeing Wichita
Each of two systems has MC 40,000; MD 60,000; and MT 13 stations.

Con Edison
MC 40,000

Convair Fort Worth
MC 40,000; MT

Esso Standard
MC 40,000; MD 60,000; MT

Farmers IG
MC 40,000; MT

Firestone
MC 40,000; MT

Ford Motor Man Ser
MC 40,000; MT

Ford Div
MC 40,000; MT

Hughes
MC 20,000; MT

Hughes
MC 20,000; MT

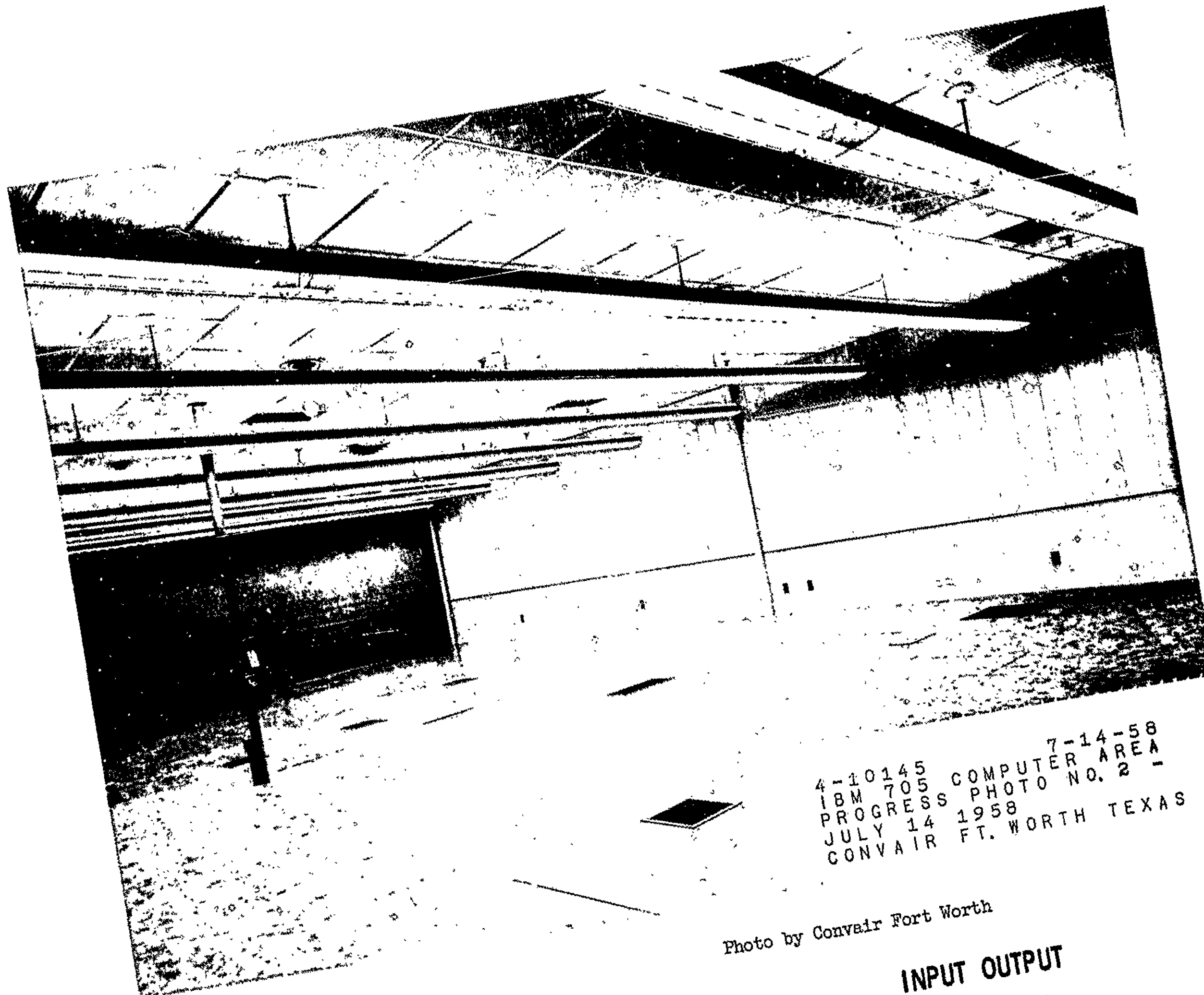


Photo by Convair Fort Worth

IH

There is one core storage unit of 40,000 positions and 10 magnetic tape stations with each of two 705 computers.

Illinois Central

MC 40,000; MT

McDonnell Aircraft

Media	No. of Char	Access Microsec
Core Storage	40,000	34 + 17 for each char
Magnetic Drum	60,000	8,000 + 40 for each char
Magnetic Tape		10,000 + 67 for each char

3M

MC 40,000; MT

Sandia Corp.

MC 40,000; MT

SOHIO

MC 40,000; MT

Texaco

MC 40,000; MT

USS TC and I

MC 40,000; MT

WE Hawthorne

Media	No. of Char	Access Microsec
Magnetic Core	40,000	17
Magnetic Drum	60,000	8,000
16 727 Magnetic Tape Units		10,000

The tape units are also used for input and output.

WE Comp Methods

MC 40,000; MD 60,000; 10 MT

INPUT OUTPUT

Manufacturer

Media	Speed
Magnetic Tape	15,000 char/sec
Card Reader	250 cards/min
Operator's Console	Manual
Magnetic Drum	25,000 char/sec
Card Punch	100 cards/min
Printer	150; 500; 1,000 lines/min
Console Typewriter	600 char/min

Three different models of printers available.

In addition to the above components, an IBM 1401 Data Processing System may be used for peripheral operations. The speeds of the 1401 components are: Card Reading - 800 cards/min, Card Punching - 250 cards/min, and Printer - 600 lines/min. The tapes from the 705 are completely compatible with the 1401 System.

Naval Construction Bn Ctr

Media	Speed
Type 714 Card Reader	250 cards/min (on-off line)
Type 727 Magnetic Tape Unit	15,000 char/sec Uses 2,400 ft reels of 1/2 inch plastic tape
Type 722 Card Punch	100 cards/min (on-off line)
Type 717 Printer	150 lines/min (on-off line)
Type 774 Tape Data	150 lines/min (on-off line)
Selector	100 cards/min

Photo by Hughes Aircraft Company

Mare Island Naval Shipyard

Media	Speed
Card Reader	250 cards/min
Magnetic Tape	15,000 digit/sec
Punch	100 cards/min
Printer	500 lines/min

Cards and printer are normally used off line.

USA TAGO

Cards	250 cards/min
Magnetic Tape	15,000 char/sec
Keyboard	Manual
Printed Report	150 lines/min

USA ABMA

Cards, Tape, Printer 150 lines/min

USA EMC

Cards, Tape, Printer 150 lines/min

USAF Tinker AFB

Magnetic Tape 22 stations; Cards; Line Printers 150 and 500 lines/min. Hi speed printer and punch are not available on line.

USAF ASO

Cards; Type 727 Tape Drives (6 1/2 minutes/reel at 15,000 char/sec; Type 720A Printer 500 lines/min; Type 407 Accounting Machine 150 lines/min; Type 519 Doc. Orig. Machine output at 100 cards/min. Types 407 and 519 are used with IBM 774 (Tape Data Selector).

USAF ADC

Tape, Cards and Printer 500 lines/min

USAF SB AMA

Tape; Cards; Printer 500 lines/min; Typewriter; Console.

USAF Olmsted AFB

Tape; Cards; Printer 500 lines/min; Typewriter

NSA

Type 727 MT; Type 717 On Line Printer 150 lines/min

AT and T, LLD

Type 727 Tape Units; Type 714 Card Reader, 60 cards/min on line; 250 cards/min off-line; Type 720A Printer max speed 500 lines/min (not used on line); Type 519 Tape Units 100 cards/min used with TDS off-line; Type 407 Printer used with TDS, max 150 lines/min; Typewriter 10 char/sec.

AT and T, TD

Tape, Cards, Type 717 Printer 150 lines/min

Boeing Wichita

Each of two systems has 13 Type 727 Tape and 1 Type 714 Card Reader on-line and 1 off-line; and a total of two 720A Printers off-line, one 720 Printer off-line, and two 722 Card Punches off-line.

Con Edison

Model 720 Printers	500 lines/min
Model 720A Printers	500 lines/min
Model 722 Card Punch	100 cards/min
Model 714 Card Reader	250 cards/min

Convair Fort Worth

Cards; Tape and Printers (600 and 150 lines/min); and Tape Data Selector. Most input/output to and from the computer stored on magnetic tape. On-line card reader used periodically for small programs or input. All printing and punching performed off-line.

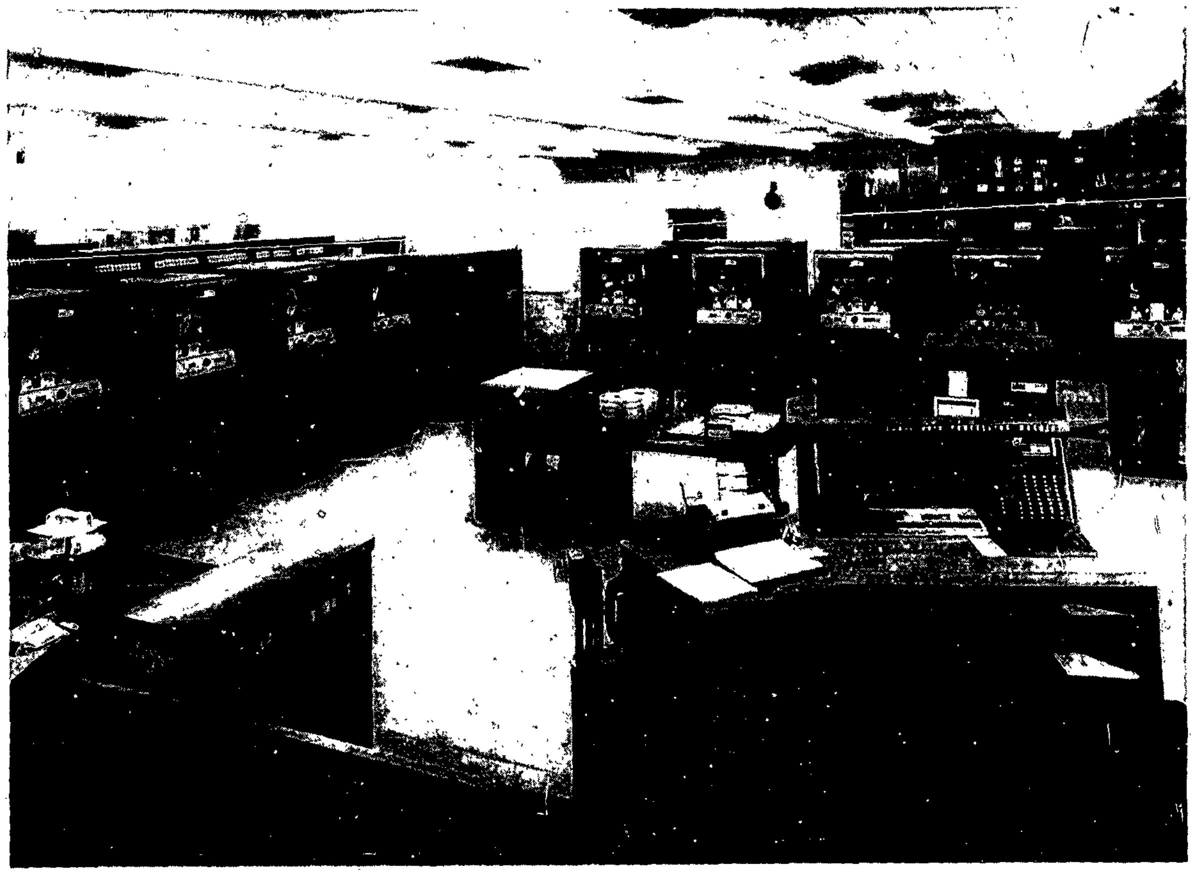


Photo by Hughes Aircraft Company

Esso Standard
Cards; Tape; Printer 150 and 500 lines/min
Farmers IG
Tape; Cards; Printer 150 lines/min; Typewriter
Firestone
Tape; Cards; 1-Printer 150 lines/min; 2 Printers 500 lines/min.
Ford Motor Man Ser
Tape; Cards; Printer 500 lines/min
Ford Div
Cards; Tape; Printer 500 lines/min
Hughes (Both Systems)
Card-to-tape; Tape-to-printer; Tape-to-card. These operations are all performed "off line" and never used for direct input-output.
IH
Card Readers (2), Tape Units (20), Printers (3) (500 lines/min). Tapes are 10 to each computer and are either used as input or as output units. Cards.
Illinois Central
Tape; Cards; Printer 500 lines/min
McDonnell Aircraft
Tape, Cards, Typewriter; Printer 500 lines/min
3M

Card Reader	250 cards/min	More speed needed
Tape	15,000 char/sec	New tape units faster w/the higher density.
Printer	500 lines/min	Never used as direct output
Punch	100 cards/min	Seldom used as direct output
Typewriter	10 char/sec	Used mainly for check points totals, etc., as to slow speed, it holds up computer process time.

Sandia Corp
Tape; Cards; Printer 150 lines/min not normally used, typewriter.
SOHIO

Cards	240 cards/min	1 card reader;on-off line
Magnetic Tape	15,000 char/sec	10 drives on line
Cards	100 cards/min	off line
Magnetic Tape	15,000 char/sec	10 on line; 3 off
Low-speed Printer	150 lines/min	on-off line
High-speed Printer	1,000 lines/min	off line

Texaco
Cards; Tape; Printer 150 lines/min; Typewriter (on-line)
USS TC and I
Magnetic Tape
WE Hawthorne
16 Type 727 Tapes, 2 Type 714 Card Readers, Type 722 Card Punch, 1 Type 717 Printer 150 lines/min, 1 Typewriter
WE Comp Methods
One card reader normally operated "Off Line" and one "On Line". Both are arranged for "On Line" operation where required. (Not at same time). There are 10 Type 727 Tape Units + 10 M/S Start-Stop/Record; 2 Type 714 Card Readers; 1 Type 717 Printer 150 lines/min.

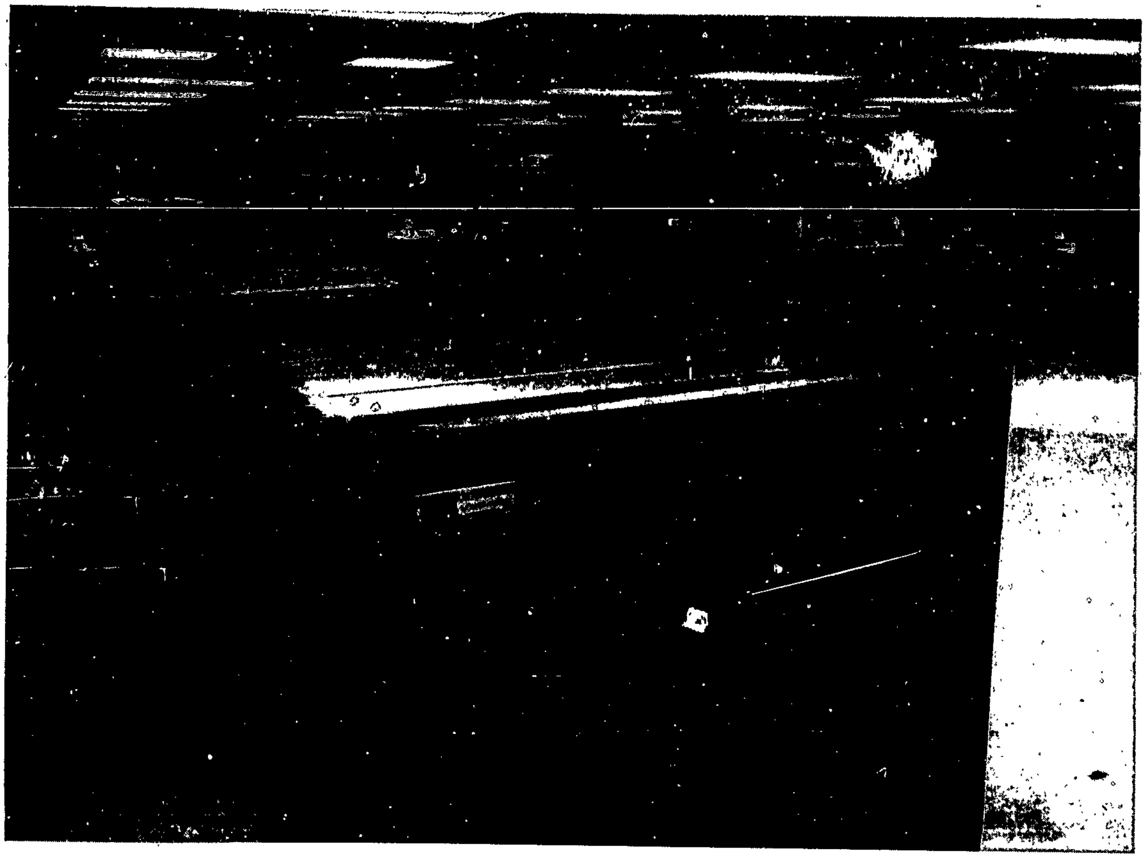


Photo by McDonnell Aircraft Corporation

2 Type 720A Printers 500 lines/min; 1 Type 722 Card Punch. Printers and punch normally operated "Off Line". All are arranged for "On Line" operation where required. (But not two 720A printers at same time).

CHECKING FEATURES

Manufacturer

Instruction validity, character coding of instruction on transfer of data, transmission of data from all input units to memory, all output data from memory to the drum tape unit, card punch storage, printer storage, and typewriter. Also, there is an overflow check, and a sign check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	69.57 Kw
Room size, computer	2,000 - 3,000 sq ft
Weight, computer	32,844

Physical planning manual is available.

Naval Construction Bn Ctr

Power, computer 103 Kw	121.0 KVA		0.92 pf
Power, air cond 55 Kw	68.0 KVA		0.80 pf
Volume, computer	2,260 cu ft		
Volume, air condition	4,200 cu ft		
Area, computer	421 sq ft		
Area, air condition	600 sq ft		
Room size, computer	40 ft x 80 ft		
Room size, air conditioner	20 ft x 45 ft		
Floor loading	200 lbs/sq ft		
	750 lbs concen max		
Capacity, air conditioner	120 Tons		
Weight, computer	40,530 lbs		

A new building to house the entire data processing facility was constructed since the existing building could not have been economically modified. A reinforced concrete structure of 20,000 sq ft was built to house the computer and related functions.

Mare Island Naval Shipyard

Power, computer	102 Kw	0.9 pf
Power, air conditioner	39 Kw	0.9 pf
Volume, computer	1,430 cu ft	
Volume, air conditioner	2,600 cu ft	
Area, computer	270 sq ft	
Area, air conditioner	360 sq ft	
Room size, computer	2,600 sq ft	
Room size, air conditioner	600 sq ft	
Floor loading	250 lbs/sq ft	
	600 lbs concen max	
Capacity, air conditioner	3 of 15 Ton units	
Weight, computer	34,120 lbs	
Weight, air conditioner	20,000 lbs	

Ceiling: Incombustible ceiling board on suspended aluminum grid, completely demountable. Plenum: Supply in suspended ceiling; return under raised floor system. Building type: Steel reinforced concrete. Building Modifications: Remove existing nonload bearing curtain wall partitions and construct new for air

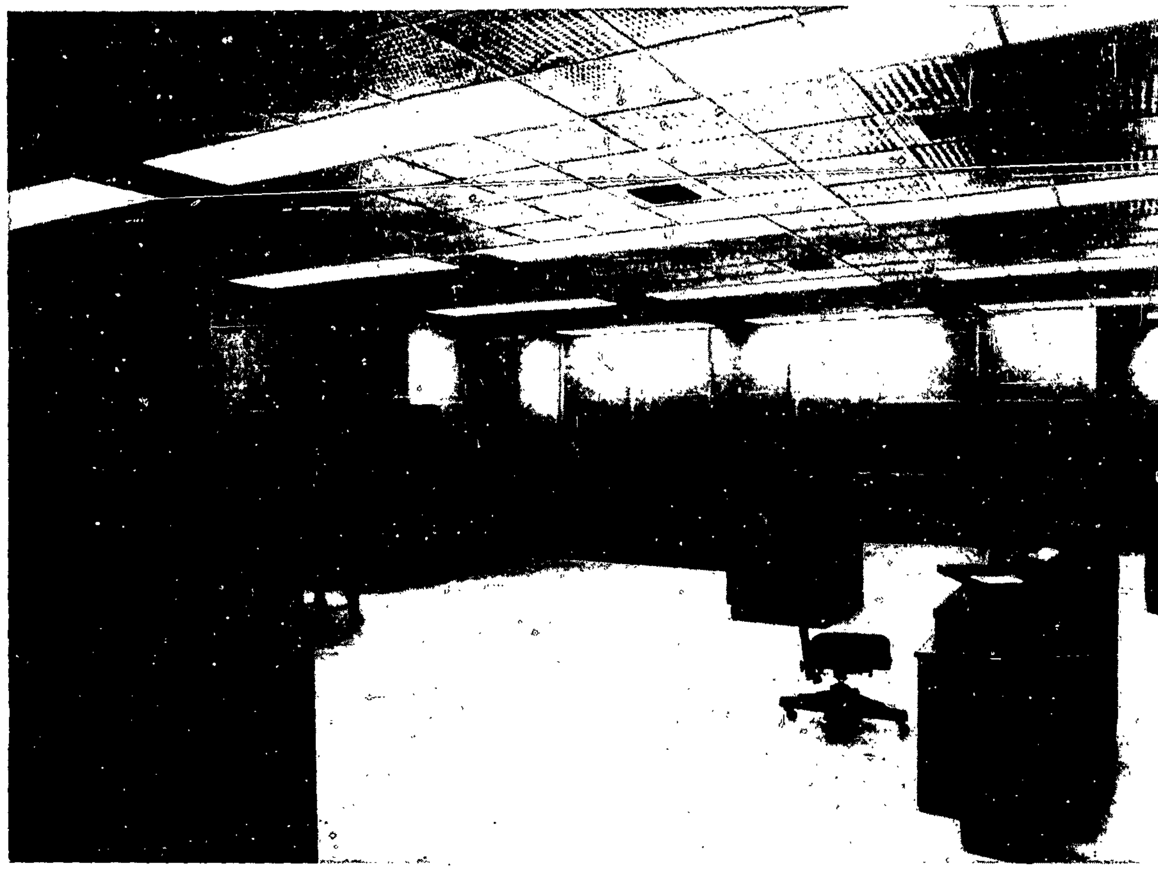


Photo by Sandia Corporation

conditioned EDPM room. Power: New separate transformer and service system for computer. New lighting and power system from existing building service. Computer transformer capacity is 150 KVA. The air conditioner transformer capacity is 300 KVA. Power is from general building service.

USA TAGO

Power, computer	119.7 KVA
Volume, computer	2,335 cu ft
Area, computer	3,575 sq ft
Area, air conditioner	95.6 sq ft
Room size, computer	55 ft x 65 ft approx.
Room size, air conditioner	25 ft x 13 ft x 12 ft
Floor loading	100 lbs/sq ft
Capacity, air conditioner	40 Tons
Weight, computer	42,290 lbs

False ceiling 8 1/2 feet above floor. Raised floors. Power is 208 volt, 3 phase, 4 wire, 60 cycles/sec.

USA ABMA

Power, computer	119 Kw	85.5 KVA	0.71 pf
Volume, computer		19,072 cu ft	
Area, computer		1,192 sq ft	
Room size, computer		2,500 sq ft	
Floor loading		25.7 lbs/sq ft	
		1,000 lbs concen max	
Capacity, air conditioner		475 Tons	

Building was built for Computation Laboratory. Concrete slab construction. The computer room has plenum floor construction with porous false ceiling for return air. Power distribution in building has its own power sub-station for isolation of the system with continuous 3 phase power distribution centers within the building. Air conditioner supports total building of 60,000 sq ft.

USA EMC

Power, computer	87.6 Kw	135.0 KVA
Power, air condi	225 Kw	225 KVA
Volume, computer		2,412.5 cu ft
Volume, air conditioner		504 cu ft
Area, computer		451.7 sq ft
Area, air conditioner		126 sq ft
Room size, computer		3,000 sq ft
Room size, air conditioner		3,000 sq ft
Floor loading		100 lbs/sq ft
		1,000 lbs concen max
Capacity, air conditioner		150 Tons
Weight, computer		44,770 lbs
Weight, air conditioner		14,640 lbs

The EMC building is of steel and concrete construction. One portion of the third floor of the building was modified for use as the computer room. The major modifications included installation of the following: air conditioning compressors, false ceiling to carry conditioned air, raised flooring to cover computer cables, observation room for visitors, and alternate underground sources of electric power with automatic switch over.

A 208 volt, 3 phase, 4 wire, 60 cycle/sec system is used. The air conditioner is fed 430 volt, 400 amp continuous current.

Photo by Sandia Corporation

USAF ASO

Power, computer	126.8 KVA
Power, air conditioner	135 KVA
Volume, computer	25,760 cu ft
Volume, air conditioner	4,200 cu ft
Area, computer	2,800 sq ft
Area, air conditioner	300 sq ft
Room size, computer	40 ft x 70 ft
Room size, air conditioner	120 ft x 70 ft (space)
	60 ft x 70 ft (machine)
Capacity, air conditioner	33.8 Tons (air handling)
	32.2 Tons (units)
Weight, computer	50,490 lbs

Building was originally a warehouse. Required installation: raised "free access" flooring, overhead air-conditioning duct, false ceiling utilized as return air plenum, 600 amp. power panel and distribute power to required units, humidity and temperature controls, CO_2 system, electronic filter, add and lower lighting, room partitions, convenience outlets every 10 feet, water pumps, cooling tower, refrigerating units, air handling units.

USAF ADC

Volume, computer	17,650 cu ft
Volume, air conditioner	7,200 cu ft
Area, computer	1,960 sq ft
Area, air conditioner	600 sq ft
Room size, computer	2,200 sq ft
Room size, air conditioner	600 sq ft
Floor loading	100 lbs/sq ft
	1,000 lbs concen max
Capacity, air conditioner	44 Tons
Weight, computer	34,000 lbs
Weight, air conditioner	15,000 lbs

Built new building with false ceiling, plenum chamber (false floor), cement block, no modification. Power distribution (separate transformer) is 400 amp, 3 phase.

USAF SB AMA

Power, computer 1	88.8 Kw	158.4 KVA	
Power, computer 2	83.8 Kw	149.2 KVA	
Power, air cond	360 Kw	450 KVA	0.80 pf
Volume, computer 1		3,179 cu ft	
Volume, computer 2		3,031 cu ft	
Volume, air conditioner		721.4 cu ft	
Area, computer 1		500 sq ft	
Area, computer 2		475 sq ft	
Area, air conditioner		144.4 sq ft	
Room size, computer 1		3,780 sq ft	
Room size, computer 2		3,780 sq ft	
Room size, air conditioner		1,600 sq ft	
Floor loading		200 lbs/sq ft	
		1,000 lbs concen max	
Capacity, air conditioner		315 TR	
Weight, computer 1		52,680 lbs	
Weight, computer 2		48,880 lbs	
Weight, air conditioner		59,250 lbs	

Weight, cubage, and space requirements for air con-

Photo by Sandia Corporation

ditioner are for chilled water equipment only. Air handling units, cooling towers, etc., are on roof of building. Site preparation included modification of approximately 25,850 sq ft of a permanent type warehouse. The modification consisted of installation of suspended acoustical ceiling, 15 inch raised floor (raised floor and suspended ceiling in 705 area only), partitions, 1500 KVA transformer station, main switch gear, distribution panels, insulating transformers, lighting, 315 TR chilled water system, air handling units on roof, and necessary duct work. Floor space, electrical power, and air conditioning tonnage not used by 705s is used by COMLOGNET and other electronic equipment.

AT and T, LLD

Power, computer		150 KVA	
Power, air conditioner	200 Kw	235 KVA	0.85 pf
Volume, air conditioner		16,000 cu ft	
Area, air conditioner		600 sq ft	
Room size, computer		4,000 sq ft	
Room size, air conditioner		1,400 sq ft	
Floor loading		100 lbs/sq ft	
		1,000 lbs concen max	
Capacity, air conditioner		170 Tons	
Weight, computer		48,000 lbs	
Weight, air conditioner		18,000 lbs	

Built new building with false floor, false ceiling, air conditioning and commercial power fed through separate transformers from 2 substations. Air conditioner is used for whole building.

AT and T, TD

Power, computer	201.8 Kw	212.5 KVA	0.949 pf
Power, air cond	151.6 Kw	198.4 KVA	0.777 pf
Volume, computer		70,831 cu ft	
Volume, air handling		6,240 cu ft	
Volume, refrig. mach.		3,240 cu ft	
Volume, cooling tower		3,000 cu ft	
Area, computer		6,589 sq ft	
Area, air handling		416 sq ft 2 floors	
Area, refrig. mach.		324 sq ft Basement	
Area, cooling tower		240 sq ft Roof	
Room size, computer		49 ft x 133 ft	
Room size, air handling		13 ft x 32 ft	
Room size, refrig. mach.		18 ft x 18 ft	
Room size, cooling tower		20 ft x 12 ft	
Floor loading		160 lbs/sq ft	
		4,860 lbs concen max	
Capacity, air conditioner		75 Tons	
Weight, computer		121,000 lbs	
Weight, air handling		16,000 lbs	
Weight, refrig. mach.		10,500 lbs	
Weight, cooling tower		10,300 lbs	
Weight, air conditioner		36,800 lbs, total	

Boeing Wichita

Power, computer		293.0 KVA	
Power, air cond	215 Kw	239 KVA	0.90 pf
Volume, computer		47,916 cu ft	
Volume, air conditioner		16,000 cu ft	
Area, computer		5,324 sq ft	
Area, air conditioner		800 sq ft	

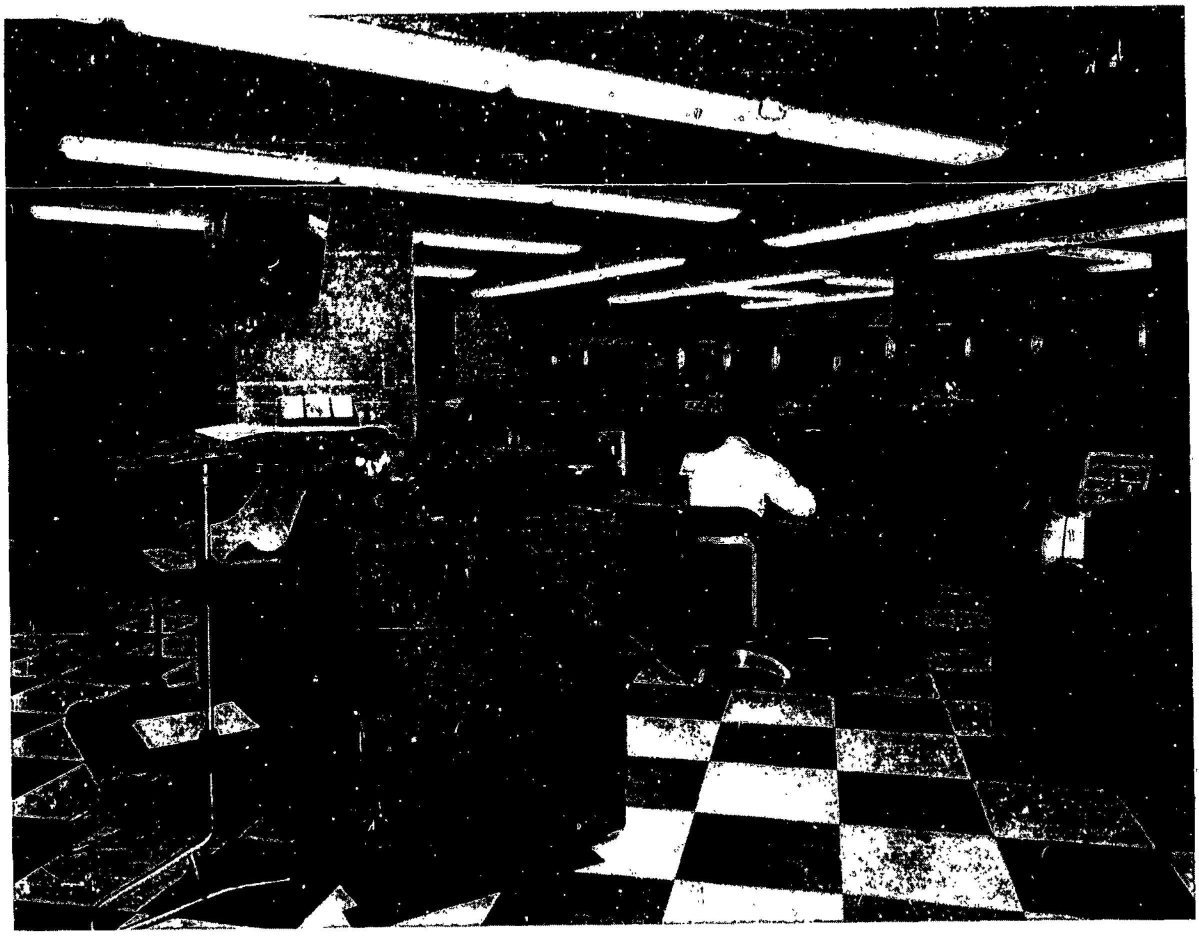


Photo by Standard Oil Company, Cleveland

Room size, computer	121 ft x 44 ft x 9 ft
Room size, air conditioner	50 ft x 16 ft x 20 ft
Floor loading	2,400 lbs/sq ft
	1,800 lbs concen max
Capacity, air conditioner	120 Tons
Weight, computer	96,050 lbs
Weight, air conditioner	28,450 lbs

All the above figures are for the two systems combined. The system is installed in a reinforced concrete building. A false ceiling covers the installation of supply ductwork, lights, and serves as a return air plenum. A raised floor was installed to provide for under floor cables and conduit. A separate transformer bank is used to supply each system.

Con Edison

Volume, computer	60,000 cu ft
Area, computer	8,000 sq ft
Floor loading	125 lbs/sq ft

Installed air conditioning, false ceilings, improved lighting, additional power supply and troughs in floor for wiring between components. Air conditioner is for most of building.

Convair Fort Worth

Power, computer	105 Kw	126 KVA	0.8 pf
Power, air condit	100 Kw	100 KVA	1.0 pf
Volume, computer		39,680 cu ft	
Volume, air conditioner		2,900 cu ft	

Area, computer	3,968 sq ft
Area, air conditioner	290 sq ft
Room size, computer	62 ft x 64 ft
Room size, air conditioner	29 ft x 10 ft
Floor loading	100 lbs/sq ft max
	1,000 lbs concen max
Capacity, air conditioner	Three 25-Ton compressors
Weight, computer	52,770 lbs
Weight, air conditioner	26,000 lbs

Installed in existing building. Raised floor (16") with open plenum construction underneath. Utilized existing hanging ceilings approximately 10 ft high. New overhead lighting installed. Power sub-station installed - two transformers for air and computer:

1 transformer 150 KVA, 4160 volt/440, 3 phase, 60 cycle

1 transformer 150 KVA, 4160 volt/208, 3 phase, 60 cycle

Since computer is installed on a wooden mezz one special precaution was taken to isolate computer floor from mezz flooring to eliminate vibration. Thus, the frame work for computer floor is tied directly to beams rising from main plant floor.

Farmers IG

Power, computer	208 KVA
Power, air conditioner	220 KVA

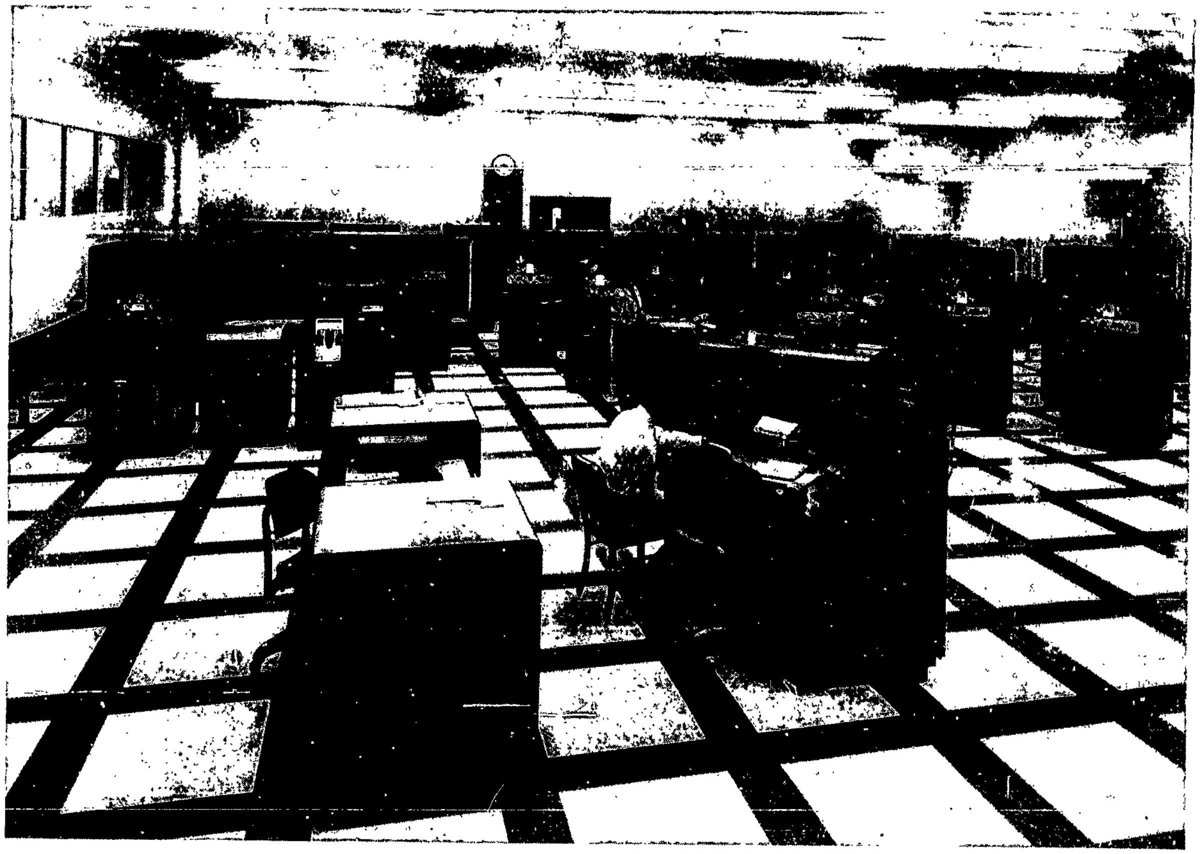


Photo by Western Electric Company, Inc., Hawthorne Works

Firestone

Power, computer	125 Kw	147 KVA	0.85 pf
Power, air cond	65 Kw	70 KVA	0.80 pf
Volume, computer		24,300 cu ft	
Volume, air conditioner		12,000 cu ft	
Area, computer		2,430 sq ft	
Area, air conditioner		1,200 sq ft	
Floor loading		125 lbs/sq ft 250 lbs concen max	
Capacity, air conditioner		50 Tons (alternate unit installed)	
Weight, computer		43,150 lbs	
Weight, air conditioner		12,500 lbs	

False floor, plenum-chamber-ceiling, power distribution panel, air conditioning control panel, and air conditioning machinery room.

Ford Motor Man Ser

Power, computer		130.7 KVA	
Power, air cond	29.8 Kw	35 KVA	0.85 pf
Volume, computer		36,800 cu ft	
Volume, air conditioner		1,000 cu ft	
Area, computer		3,680 sq ft	
Area, air conditioner		100 sq ft	
Floor loading		Ground floor solid concrete	
Capacity, air conditioner		38 Tons	
Weight, computer		52,360 lbs	
Weight, air conditioner		4,000 lbs	

The Rouge Office Building was in the design stage at the time the computer was ordered. The only changes made were as follows: trenches were installed in the floor for cables, additional overhead air conditioners and humidifiers were installed, and since the installation of the 702 Computer a line filter has been installed to handle the peaks and valleys in the voltage to the machine.

Ford Div

Power, computer	150 KVA
Volume, computer	6,279 cu ft
Volume, air conditioner	9,255 cu ft
Area, computer	2,046 sq ft
Area, air conditioner	617 sq ft
Room size, computer	34.8 x 59 ft
Room size, air conditioner	17.75 x 34.75 ft
Floor loading	Unlimited
Capacity	50 Tons (plus 10-Ton in adj. area)
Weight, computer	34,000 lbs

3 foot false ceiling, 12 inch air plenum with outlets below ventral processing unit and power supply, concrete block building, and false floor of reinforced aluminum and vinyl tile.

Hughes

Power, computer	201 Kw	201 KVA	Unity Synchronous Motor Generator
Power, air cond	57 Kw	71 KVA	approx. 0.80 pf Induction motor driven
Volume, computer		30,365 cu ft	
Volume, air conditioner		4,620 cu ft	
Area, computer		2,977 sq ft	
Area, air conditioner		420 sq ft	

Room size, computer 60 ft x 43 ft
20 ft x 22 ft
Room size, air conditioner 15 ft x 28 ft
Floor loading 100 lbs/sq ft
1,000 lbs concen max
(per caster)
Capacity, air conditioner 56.8 Tons
Weight, computer 46,620 lbs
Weight, air conditioner 1,500 lbs

Building type: 3B-tilt-up concrete block wall with wood truss roof. Site preparation: Demolition of existing partitions; installation of raised floor, insulated with alum; "Dryfol" and mounted on 1/8 in. rubber; construction of separate but attached air conditioning, generator, and tape storage rooms; install two duct, two air conditioning systems; install 120/208 volt-3 phase-4 wire-600 amp. power panel for IBM equipment, using existing 400 amp. panel for lighting, etc.; and install acoustical tile on existing ceiling.

Hughes

Power, computer 225 Kw 225 KVA Unity
Area served by separate transformer
Volume, computer 23,386 cu ft
Volume, air conditioner 8,000 cu ft
Area, computer 2,126 sq ft
Area, air conditioner 1,000 sq ft
Room size, computer 47 ft 6 in x 45 ft
Room size, air conditioner 50 ft x 20 ft
Capacity, air conditioner 11.6 Tons
Weight, computer 29,110 lbs

A portion of subject building is leased from the Service Bureau Corporation. Therefore, power, air conditioning systems, and site preparations were lessor installed. The following work was performed by lessee in occupying space: installed electrical runs from existing power panel to IBM units; installed electrical receptacles; and installed air deflection registers in elevated steel plate floor.

IH

Power, computer & perip. 127 Kw 211.5 KVA 0.6 pf
Power, air conditioner 71 Kw 83.5 KVA 0.85 pf
Volume, computer & periph. 34,200 cu ft
Volume, air conditioner 3,103 cu ft
Area, computer & per. equip. 3,420 sq ft
Area, air conditioner 387 sq ft
Room size, comp & perip. equip 76 ft x 45 ft
Room size, air conditioner 18 ft x 31 ft x 6 in.
17 ft x 40 ft x 11'6"
Capacity, air conditioner 82 1/2 Tons
Weight, computer 69,720 lbs
Weight, air conditioner 34,384 lbs
Floor loading 20.5 lbs/sq ft
100 lbs concen max

False wooden floor atop concrete, false ceilings with air conditioning ducts constructed therein, prefab steel constructed walls-glass windows all around. Air conditioning equipment for computer installation completely separate from rest of building.

Illinois Central

Power, comp. & components 98 Kw 156.8 KVA 0.62 pf
Power, air conditioner 120 Kw 150.0 KVA 0.80 pf
Volume, comp. & components 29,598 cu ft
Volume, air conditioner 40,285 cu ft
Area, comp. & components 503 sq ft
Area, air conditioner 1,985 sq ft
Room size, comp. & components 40 ft x 96 ft
Room size, air conditioner 49 ft x 37 ft
Capacity, air conditioner 91.8 Tons
Weight, computer 507,900 lbs
Weight, air conditioner 16,000 lbs

False floor reinforced steel beam construction. False ceiling, acoustical with diffused air-conditioning and recessed light fixtures. Room of brick construction with inside wall of Johns Mansville construction. Power supplied by public utility company.

McDonnell Aircraft

Power, computer 162.5 KVA
Floor loading 100 lbs/sq ft
100 lbs concen max
Capacity, air conditioner 75 Tons
Weight, computer 48,400 lbs

3M

Power, computer 250 Kw 300 KVA 0.84 pf
Power, air conditioner 40 Horsepower
Volume, computer 25,780 cu ft
Volume, air conditioner 13,000 cu ft
Area, computer 3,870 sq ft
Area, air conditioner 1,300 sq ft
Room size, computer 34 ft 6 in x 81 ft 6 in
14 ft 6 in x 26 ft 6 in
14 ft 6 in x 12 ft 6 in
23 ft x 20 ft 6 in
Room size, air conditioner 21 ft 6 in x 60 ft 6 in
Floor loading 100 lbs/sq ft
500 lbs concen max
Capacity, air conditioner 40 Tons
Weight, computer (705 only) 5,300 lbs ea, 10,600 total
Weight, air conditioner 41,000 lbs, total

Raised floor for power and computer cables. Installed separate air conditioning unit and power transformer.

Sandia Corp.

Power, computer 121 Kw 70 KVA 1.732 pf
Power, air cond 49 Hp 60 KVA 0.8 pf
Volume, air conditioner 7,440 c[illegible]
Area, air conditioner 744 [illegible]
Room size, computer 50 ft x 100 ft
(25 ft x 25 ft vault)
Room size, air conditioner 24 ft x 31 ft
outside tower
Floor loading 3,580 lbs concen max
Capacity, air conditioner 60 Tons steam fired
absorption unit
Weight, computer 24,480 lbs
Weight, air conditioner 20,000 lbs

The following alterations were made to an existing building: raised floor (free access); false ceiling; eight (8) plenums; and installation of air conditioning and power. The air conditioning is a built-up system.

SOHIO

Power, computer 113.1 Kw 125.7 KVA 0.90-0.92 pf
Power, air cond 153.2 Kw 170.0 KVA 0.90-0.92 pf
Volume, computer 2,550 cu ft
Area, computer 500 sq ft
Area, air conditioner 2,500 sq ft (including
space used in ceiling and floor)
Room size, computer 2,850 sq ft
21,000 cu ft
Room size, air conditioner 4,139 sq ft
Floor loading 100 lbs/sq ft
1,000 lbs concen max
Capacity, air conditioner 60 Tons
Weight, computer 42,580 lbs
Weight, air conditioner 53,650 lbs

False ceilings; false floors; converted individual offices into one main room; installed separate air conditioning and humidity controls (with stand-by equipment); installed fire hose; installed separate power lines from transformer to computer room; and installed exhaust hoods for main frame and control units.

Texaco

Power, computer 129.4 KVA
Volume, computer 31,860 cu ft

Volume, air conditioner	4,320 cu ft	
Area, computer	2,375 sq ft	
Area, air conditioner	540 sq ft	
Room size, computer	2,655 sq ft	
Room size, air conditioner	18 ft x 30 ft	
Floor loading	900 lbs concen max	
Capacity, air conditioner	80 Tons	
Weight, computer	31,870 lbs	

Building area was cleared of old partitions and new walls of tile and plastic were constructed. New false ceilings constructed of aluminum acoustical panels which also serve as input areas for air to machine room. Air returned to blower system via plenum construction. Air system protected by electrostatic and standard filters. Free access or pedestal type of floor constructed of 27 inch square metal plates.

USS TC and I

Power, computer	116.8 KVA	
Power, air conditioner	22.5 KVA	0.85 pf
Volume, computer	18,400 cu ft	
Volume, air conditioner	9,792 cu ft	
Area, computer	2,300 sq ft	
Area, air conditioner	1,152 sq ft	
Room size, computer	56 ft x 41 ft	
Room size, air conditioner	48 ft x 24 ft	
Floor loading	120 lbs/sq ft	
	200 lbs concen max	
Capacity, air conditioner	34.8 Tons	
Weight, computer	37,530 lbs	
Weight, air conditioner	10,600 lbs	

Ceiling lowered 18 inches for duct work, installed 26 plenums, added relays and separate power transformer servicing EDP equipment only.

WE Hawthorne

Power, computer	200 Kw
Power, air conditioner	175 Kw
Volume, computer	77,000 cu ft
Volume, air conditioner	9,500 cu ft
Area, computer	7,000 sq ft
Area, air conditioner	866 sq ft
Floor loading	85 lbs/sq ft
Capacity, air conditioner	80 Tons
Weight, computer	60,570 lbs

Computer installed in top floor of existing office building. 10 inch raised steel floor, sectionalized 3 ft x 3 ft for running cables. Outside windows insulated. Entire area sprinkler protected. All air-conditioning overhead except for special duct to main frame.

WE Comp Methods

Power, computer 253 Kw 281 KVA approx. 0.90 pf
Only 55% required for present equipment.
Power, air conditioner 250 KVA
332 HP installed. Not more than 215 HP used at any one time. Balance standby.

Volume, computer	47,000 cu ft
Volume, air conditioner	15,300 cu ft
Area, computer	5,200 sq ft
Area, air conditioner	1,225 sq ft
Room size, computer	5,200 sq ft
Room size, air conditioner	1,225 sq ft
Floor loading	200 lbs/sq ft
	700 lbs concen max
Capacity, air conditioner	two 100 Ton Units
	one 50 Ton Unit
Weight, computer	53,760 lbs
Weight, air conditioner	22,850 lbs

Building: steel frame, brick walls. Equipment on 5th floor (top). False ceiling (Accustone) suspended from roof beams under original suspended ceiling. Raised (18") steel plate floor, vinyl tile covered. Original floor wood covered concrete over arched hollow tile ceiling. Wood covering removed and resurfaced with cement. Air inlet ducts above false ceiling and beneath raised floor. Common return ducts above false ceiling. Recessed trough lighting. Area enclosed with sheet steel partitions two 300 KVA transformers (one is standby) installed on roof and fed from 13,800 volt main circuits from own power house. Air conditioning and lighting power taken from existing 440 volt mains.

PRODUCTION RECORD

Manufacturer

There is only limited production on this system at the present time. Delivery on availability basis only.

COST, PRICE AND RENTAL RATES

Manufacturer

		Monthly Charge	Purchase Price
705	Central Processing Unit w/40,000 positions core memory	$14,150	$590,000
714	Card Reader	1,500	64,450
717	Printer (150 lines/min)	1,400	55,000
720	Printer (500 lines/min)	1,900	93,000
722	Card Punch	800	43,300
727	Magnetic Tape Unit	550	18,200
730	Printer (1,000 lines/min)	3,900	210,500
734	Magnetic Drum Storage	2,300	90,000
735	Printer Control (730 & 760)	600	32,500
744	Magnetic Drum Power Supply	500	21,500
745	Power Supply	1,200	62,400
754	Tape Control	1,500	78,000
757	Printer Control	650	44,000
758	Card Punch Control	600	36,000
759	Card Reader Control	900	45,000
760	Control & Storage	2,500	111,000
777	Tape Record Coordinator	3,400	156,000
782	Console and Typewriter	1,000	52,000

Monthly rental, average system: $33,500 & up
Purchase, average system: $1,640,000 & up
Maintenance contract is available.

Naval Construction Bn Ctr

Rental contracting and rates for basic system

Type 705 CPU	$11,650
Type 782 Console and Typewriter	1,000
Type 745 Power Supply	1,200
Type 754 Tape Control Unit	1,500
Type 727 Magnetic Tape Units (10)	5,500
Total	$20,850

Rental rates for additional equipment

Type 714 Card Reader	$1,510
Type 759 Card Reader Control	935
Type 717 Printer	1,400
Type 757 Printer Control	650
Type 722 Card Punch	800
Type 758 Card Punch Control	650
Type 727 Magnetic Tape Units (4)	2,200
Type 747 TDS Power Supply	500
Type 774 Tape Data Selector	2,524
Total	$11,169

Mare Island Naval Shipyard

Basic system consisting of 705 II Computer, 782 Console, 10-727 Tape Units, 745 Power Supply, 754 Tape Control, rents at $23,350/month.

Additional equipment consisting of 714 Card Reader, 720A Printer, 722 Punch, 2-727 Tape Units, 759 Control, 760I Control, 758 Control, rents at $9,350/mo.

USA TAGO

Basic System (Prime Shift)

Type 705, 714, 717, 727 (12 units), 745, 747, 754, 757, 758, 759, 774, 782, 407, 519 - total rental $34,425.

Additional Equipment (EAM)

11 tp 024, 6 tp 056, 4 tp 082, 2 tp 085, 4 tp 407, 1 tp 552, 2 tp 026, 1 tp 080, 3 tp 083, 1 tp 101, 2 tp 519, 1 tp 557 - total monthly rental $6,120.

USA ABMA

705, 714, 14-727's, 745, 2-754's, 759, 782 - $29,450 per month (includes maintenance).

USA EMC

Basic System	Monthly Rental
1 705 Central Proc. Unit	$14,150
1 745 Power Unit	1,200
1 782 Console	1,000
1 714 Card Reader	1,500
1 759 Control Unit	900
2 717 Printers	2,800
2 757 Control Units	1,300
1 722 Card Punch	800
1 758 Control Unit	650
16 727 Tape Units	8,800
2 754 Tape Control	3,000
Total Basic Operational Use Monthly Rental	$36,100

USAF Tinker AFB (2)

Type	Name	Quantity
705	Central Processing Unit	1
714	Card Reader	2
717	Printer	1
720	Printer	1
722	Card Punch	1
727	Tape Unit	30
734	Drum Storage Unit	1
744	Drum Power Unit	1
745	Power Unit	1
754	Tape Control Unit	1
757	Printer Control Unit	1
758	Card Punch Control Unit	1
759	Card Reader Control Unit	2
760	Control and Storage Unit	1
777	Tape Record Coordinator	2
782	Console and Typewriter	1
774	Tape Data Selector	1
747	TDS Power Supply	1
519	Document Machine	1
407	Accounting Machine	1

Total cost $61,910 prime shift/month. Each system configuration is the same.

USAF ASO

Basic System

2 705 II's with 4 TRC's, 2 drums and 30 tape drives-$68,400/month.

Additional Equipment

2 Card Readers, 2 high speed printers, 2 TDS units (with 407 and 519), and 6 tape drives - $24,342/month.

USAF ADC

Basic System

$1,393,550

Basic System

$32,650/month.

Service contracting - $5,295.75/month.

USAF SB AMA

First System (Basic)

Qty	Type	Description	Monthly Rental Prime Shift
1	705-I	Central Processing Unit	$14,150
1	745	Power Supply	1,200
1	782	Console and Typewriter	1,020
1	714	Card Reader	1,615
1	759	Card Reader Control	900
26	727	Magnetic Tape Unit	14,300
2	734	Magnetic Drum Storage	4,600
2	744	Magnetic Drum Power	1,000
1	754	Tape Drive Control Unit	1,500
2	777	Tape Record Coordinator	6,800
38 Pieces, Total system			$47,085

Second System (Basic)

Qty	Type	Description	Monthly Rental Prime Shift
1	705-2	Central Processing Unit	$14,150
1	745	Power Supply	1,200
1	782	Console and Typewriter	1,020
1	714	Card Reader	1,615
1	759	Card Reader Control	900
22	727	Magnetic Tape Unit	12,100
2	734	Magnetic Drum Storage	4,600
2	744	Magnetic Drum Power	1,000
1	754	Tape Drive Control Unit	1,500
2	777	Tape Record Coordinator	6,800
34 Pieces, Total system			$44,885

Additional Equipment

Qty	Type	Description	Monthly Rental Prime Shift
1	714	Card Reader	$1,615
1	759	Card Reader Control	900
1	720A	High Speed Printer	1,900
1	760	Control and Storage	2,500
1	722	Card Punch	800
1	758	Punch Control	650
4	724	Magnetic Tape Unit	2,200
1	774	Tape Data Selector	2,500
1	747	Tape Data Selector Power Supply	500
1	717	Printer	1,400
1	754	Printer Control	700
1	727	Magnetic Tape Unit	550
15 Pieces, Total system			$16,215

USAF Olmsted AFB

Qty	Component	Rental
1	Central Processing Unit, Mdl 2	$14,150
2	Card Reader, Mdl 1	3,000
2	Printer, Mdl 1	3,000
1	Card Punch, Mdl 1	800
25	Tape Unit, Mdl 1	13,750
1	Magnetic Drum Power, Mdl 1	500
1	Magnetic Drum Storage, Mdl 1	2,300
1	Power Supply, Mdl 1	1,200
1	Tape Cotl, Mdl 1	1,500
1	Card Punch Control, Mdl 1	600
2	Card Reader, Control, Mdl 1	1,800
2	Control & Storage, Mdl 1	5,000
2	Tape Record Coordinator, Mdl 1	6,800
1	Console & Typewriter, Mdl 1	1,000
	Total Basic Rental Cost	$56,200

AT and T, LLD

Rental for 176 hours per month - Overtime is at 40% of rate for first 176 hours.

Present monthly rental including overtime is approximately $55,000.

Equipment	176 hour rental
IBM 705 II equipped w/console, drum, 15 727 tape units, 2 777 TRC's, power supply and special card reader (modified 026 Keypunch)	$34,550
720A Printer equipped w/760 Control Unit and a 727 tape unit	4,950
714 Card Reader equipped w/759 Control Unit and a 727 tape unit	2,995
774 TDS equipped w/407 Tabulator, 519 Reproducing Punch, 747 Power Unit, and 727 Tape Unit.	5,305
Total	$47,800

AT and T, TD

CPU $14,150; 2-714 3,000; 3-720A 5,700; 1-730 3,900; 1-782 1,000; 19-727 10,450; 2-777 6,800; 1-826 145; 1-717 1,400; miscellaneous power and control units $14,300.

Boeing Wichita

Basic System

705CPU, drum, card reader, 2 TCU's, 14 tape drives $32,260 per month (each of two systems).

Additial Equipment

3-720A's, 1 card reader, 2 punches, 6 tape drives $22,310 per month.

Con Edison

2-705 Model II with 40 K memory and TRCs and 16 tape stations each, 3-714 Card Readers, 3-722 Card Punches, 3-720 Printers, 3-720A Printers $107,000/monthly

Convair Fort Worth

Qty	Description	Rental Month	Excise Tax
1	705 Model II C.P.U.	$14,150	
1	745 Power Unit	1,200	
1	782 Console	1,000	
2	714 Card Readers	3,020	
2	759 Card Reader Control Unit	1,800	
14	727 Tape Units	7,700	
1	717 Printer	1,400	
1	757 Printer Control Unit	650	
1	720A High Speed Printer	1,900	
1	760 Printer Control Unit	2,500	
1	754 Tape Control Unit	1,500	
1	774 Tape Data Selector Model I with file search feature	2,300	$230.00
1	747 Tape Data Selector Power Unit	500	50.00
1	407 Tab. Model A2 - Mod. for T.D.S.	910	91.00
1	519 Punch Model 1 - Mod. for T.D.S.	210	21.00
1	046 Tape to Card Punch	161	16.10
1	026 Printing Key Punch	60	6.00
	Total	$40,961	$414.10
	Grand Total	$41,375.10	

Esso Standard

Basic System

CPU, drum, 2 card readers, 1 card punch, 2 printers, 14 tape drives, tape data selector, condole, power and control units - $47,000/month, prime shift.

Additional Equipment

Keypunches and verifiers, sorters, collators, tabulator, calculators, interpreters, summary punches, etc. in support of 705 - $13,000/month.

Firestone

Main frame, TCU, 11 tapes, card reader, console cost $1,093,500 and rents at $28,370/month.
4 tapes, 717 Printer, 2 720 Printers, card reader, card punch cost $699,150 and rents at $13,850/month.

Ford Motor Man Ser

	Machine	Monthly Rental
705	Central Process Unit	$14,425.92
712	Card Reader	790.11
712	Card Reader	774.82
717	Printer (2)	3,874.10
722	Card Punch (2)	1,631.20
727	Magnetic Tape Unit (15)	8,410.95
745	Power Supply	1,223.40
754	Tape Control Unit	1,529.25
756	Card Reader Control (2)	632.08
757	Printer Control Unit (2)	5,097.44
758	Punch Control Unit (2)	1,223.40
782	Console Typewriter	1,019.50
		$40,632.17

Ford Div

Rental	$ 32,500
Approx. cost price	$1,300,000.

Hughes

Machine Type	Qty	Monthly Rental
705	1	$11,650
714	1	1,500
720	2	2,800
722	1	800
727	15	8,250
745	1	1,200
754	1	1,500
758	1	650
759	1	900
760	2	5,000
777	2	6,800
782	1	1,000
	Total	$42,050

Hughes

Machine Type	Qty	Monthly Rental
705	1	$11,650
727	12	6,600
745	1	1,200
777	2	6,800
782	1	1,000
	Total	$27,250

IH

Basic System

2 Central Processing Units
2 Power Supply Units
2 Console Typewriters
25 Tape Units
2 Tape Control Units
2 Card Readers
2 Card Header Central Units
3 Printers
3 Printer Control & Storage
1 Card Punch
1 Card Punch Central

$69,826/month.

Additional Equipment

1 407 Printer	1 514 Reproducer
1 077 Collator	2 026 Keypunches
1 552 Interpreter	1 082 Sorter
2 101 Statistical Machines	

$2,230/month.

Illinois Central

CPU with buffers	$23,000/month.
13 tape drives	7,150/month.
2 720A Printers	8,800/month.
2 card readers	4,800/month.
1 card punch	1,400/month.
4 tape drives	2,200/month.

McDonnell Aircraft

Basic System

705 II with magnetic drum, 10 tapes, reader, two 720 Printers, and punch cost $1,888,600 and rent at $44,180/month.

Additional Equipment

024, 026, 056, key punch and verifiers; 077, 085, 087, 089 collators; 083 sorters; 101 sorters, 407 tabulators, 408 Bill Weed and tabulation, 519, 521, 528 punches; 604 calculators, 954 posting machine cost $1,227,345 and rent at $26,000/month.

3M

Basic System

705 Model II, 745 Power supply, 782 Console, 754 Tape Control, 10 ea. 727 Magnetic Tape Drives cost $956,360 each (2 systems) and rents at $23,500/month each.

Additional Equipment

714 Card Reader, 759 Card Reader Control, 720 Printer, 760 Control Storage, 720A Printer, 760 Control Storage, 722 Card Punch, 758 Card Punch Control, 2 ea. 727 Magnetic Tape Units cost $418,075 and rents at $13,330/month.

Maintenance is $2,513.50 for prime shift for each basic system listed above.

Sandia Corp.

Basic System

One 705 II CPU and power, printer, card reader, and ten 727 tape units rent at $32,000 monthly rental.

Additional Equipment

A 720 Printer and a TDS with 407 and 519 rent at $8,000/month.

Maintenance and service are provided by vendor.

SOHIO

Basic System	Cost	Monthly Rental
Central Processing Unit 705 Model II	$590,000	$14,150
Power Unit (745)	62,400	1,200
Console (782)	52,000	1,000
10 Magnetic Tape Units (727)	182,000	5,500
Tape Control Unit (754)	78,000	1,500
Additional Equipment		
Card Reader (714)	$64,450	$1,615
Reader Control (759)	45,000	900
Printer (717)	55,000	1,400
Printer Control (757)	44,000	650
4 Magnetic Tape Units (727)	72,800	2,200
Printer (730A)	210,500	3,900
Printer Control (735)	32,500	600
Storage Control (760) Model II	111,000	2,500
Card Punch (722)	43,300	800
Punch Control (758)	36,000	650

Texaco

Basic System

CPU, on line printer, reader, punch and 10 tapes.
Peripheral equipment: 2-720A, 1-714 and 1-722.
Rent - primary shift $44,000/month.

USS TC and I

1 CPU; 1 card reader; 1 punch control; 1 console; 1 reader control; 2 printers; 1 power unit; 1 card punch; 2 printer controls; 11 tape drives; 1 tape control. Total cost $31,800/month.

WE Hawthorne

Qty	Basic System	Monthly Rental(1)
1	705 CPU - 40K	$14,150
1	745 CPU Power	1,200
1	782 Console	1,000
2	754 Tape Control Units	3,000
16	727 Tape Units	8,800
1	734 Drum	2,300
1	744 Drum Power	500
1	714 Card Reader	1,500
1	759 C. R. Control	900
		$33,350
	Additional Equipment	
1 (2)	717 Printer	$1,400
1 (2)	757 Printer Control	650
2	720 Printer	2,800
2	760 Printer Control	5,000
1 (2)	714 Card Reader	1,500
1 (2)	759 C. R. Control	900
1 (2)	722 Card Punch	800
1 (2)	758 Punch Control	650
5	727 Tape Units	2,750
		$16,450

Notes:

(1) Monthly charge covers the first 176 hours a month the system is in use. Each hour of use thereafter is billed at the rate of 1/176th of 40% of the monthly charge.

(2) May be operated "on-line".

WE Comp Methods

Basic System

IBM 705 Mod. II; 10 Type 727 Tape Units; 1 Type 754 Tape Unit; control 1 Type 734 Drum; 1 Type 714 Card Reader; rental is $28,560/month.

Additional Equipment

1 Type 714 Card Reader; 1 Type 717 Printer; 1 Type 722 Card Punch; 2 Type 720A Printers; controls; and 6 Type 727 Tape Units rent for $18,010/month.

PERSONNEL REQUIREMENTS

Manufacturer

Operator, programming, and technical training is available as well as assistance at all levels.

Naval Construction Bn Ctr

	One 8-Hour Shift		Two 8-Hour Shifts	
	U	Rec	U	Rec
Supervisors			9	
Analysts	5		5	
Programmers & Coders	18	22	18	22
Clerks	1		1	
Librarians	1		2	
Operators	1		2	
In-Output Oper	3		4	
Tape Handlers	2		4	

Personnel includes Yards and Docks Supply Office. Engineers and technicians are furnished by contractor.

Operation tends toward closed shop.

Methods of training used includes formal classroom and on-the-job.

Mare Island Naval Shipyard

	Three 8-Hour Shifts Used	Recommended
Supervisors	5	6
Programmers	11	15
Clerks	4	4
Operators	6	6
In-Output Oper	10	10

Personnel supervisor requirements shown are for consolidated EDP-EAM operations, programming and administration. Supervisors shown are:

Head, Data Processing Center
Head, Programming (Vacant)
Head, Operations
3 Operations Shift Supervisors

Programmer performs functions in Data Processing Center. Analysts are in various departments and may work on any project.

Some clerical control and balancing operations performed by EAM Operators who also operate equipment. Equivalent effort of about two clerks relative to EDP portion. Clerical staff of two persons handle combined EAM-EDP administrative requirements; i.e., filing, letters, personnel actions, etc.

Librarian and tape handling functions performed by peripheral equipment operators.

Engineers and technicians furnished by manufacturer under rental contract.

Operation tends toward closed shop.

Methods of training used includes: programmers - manufacturer's standard programming course (4 weeks plus on-the-job experience) and operators - on-the-job training.

USA TAGO

	One 8-Hour Shift Used	Recom	Two 8-Hour Shifts Used	Recom
Supervisors	2	2	2	2
Analysts	21	21		
Programmers & Coders	32	32		
Clerks	6	6		
Librarians			2	2
Operators			4	4
In-Output Oper			4	4
Tape Handlers			2	2

Operation tends toward open shop.

Methods of training used includes IBM conducted classes and on-the-job training.

USA ABMA

	One 8-Hour Shift
Supervisors	1
Analysts	11
Programmers	4
Clerks	1
Librarians	1
Operators	2
Engineers IBM	12
In-Output Oper	2

One additional supervisor is required for each additional 8-hour shift. Three additional input-output operators are required for a second 8-hour shift and two additional input-output operators are required for a third 8-hour shift.

Operators are used on 704's, 705 and 709 in rotating shifts.

The 12 IBM engineers rotate shifts on the 704's and 709.

Operation tends toward open shop.

Methods of training used includes on-the-job and formal schooling for programmers and operators.

USA EMC

The computer is operated three shifts a day five days a week. The actual operating hours are continuous from 7:30 A.M. each Monday through 7:30 A.M. the following Saturday. One console operator and two peripheral equipment operators man each shift. These peripheral operators assist the console operator by mounting and dismounting on tape drives which are involved in main frame operations. The operators also perform all "off-line" operations.

The computer room supervisor is assigned to the basic shift (7:30 A.M. - 4:00 P.M.). A tape librarian is also assigned to the basic shift.

Ten analysts are employed in the researching of new projects and the feasibility of utilizing new types of equipment. These analysts also write the basic logic for new operations.

These nineteen people assigned to writing programs. This program writing consists of writing new programs, changing existing programs because of changes in criteria, changing programs so as to take advantage of new programming techniques.

Operation tends toward closed shop.

Programmers receive a basic course in programming from the IBM Corporation. This course runs from three to five weeks depending on the amount of detailed instruction given and practice allowed. At the end of the course the new programmers are assigned to work with more experienced programmers until they become self sufficient.

The original group of console operators and peripheral equipment operators received the basic programming course from the IBM Corporation. The actual operation of the equipment was taught, on the job, by IBM personnel. The more recent additions to the force of peripheral operators have not received the programming course from IBM. They have learned the operation of the equipment, on the job, from our more experienced operators.

USAF Tinker AFB (2)

Supervisors	1
Clerks	0
Librarians	2
Operators	4
Tape Handlers	12

Above requirements is for each system.

Machine operated three (3) shifts seven (7) days per week.

Programmers and coders cannot be identified with individual system.

USAF ASO

	Three 8-Hour Shifts
Supervisors	25
Analysts	14
Programmers	35
Coders	6
Clerks	40
Librarians	3
Operators	40
Engineers	8
Technicians	3
In-Output Oper	8
Tape Handlers	2

Methods of training used includes IBM Educational Center and on-the-job training.

USAF ADC

	Two 8-Hour Shifts Used	Recommended
Supervisors	5	5
Analysts	1	1
Programmers	22	24
Coders	0	2
Clerks	3	3
Librarians	1	1
Operators	4	4
Engineers	2	2
Technicians	0	0
In-Output Oper	2	2
Tape Handlers	2	2

Operation tends toward closed shop.

Programmers attend 705 Course conducted by IBM. On returning to this unit, but after completing practice problem where review of programming techniques are reviewed, programmers are assigned under the supervision of a senior programmer where on-the-job training continues until reaching the fully qualified level.

Operators attend 705 Course conducted by IBM. Other training is obtained through on-the-job training.

USAF SB AMA

SBAMA EDP personnel requirements support the logistical mission. Additional personnel support the PCAM effort. PCAM is utilized in an integrated data processing system to provide extra off-line capability. Coders are included in the programmer category.

Because of the varying quantitative effect and diverse character of the workload in the AMC logistical support, an inflexible recommendation of personnel was not attempted. Cross-trained personnel qualified to employ techniques in various computer configurations provide system flexibility.

Engineers and technicians to service and maintain the EDP equipment are provided on a contractual basis by the manufacturer concerned.

Extra shift time for analysts, programmers and clerks is not on a regularly scheduled basis. Whenever the workload occasion demands, personnel hours are specially scheduled.

Systems Analysis, Development and Programming staff operate on one 8-hour daily shift, 5 days per week. Computer operations staff work on three 8-hour daily shifts, 7 days weekly.

Operation tends toward closed shop.

Methods of training used includes formal training by manufacturer and on-the-job training.

USAF Olmsted AFB

	One 8-Hour Shift Used	One 8-Hour Shift Recom	Three 8-Hour Shifts Used	Three 8-Hour Shifts Recom
Supervisors	1	1	3	3
Analysts	5	5		
Programmers	10	10		
Librarians			2	2
Operators			5	5
In-Output Oper			5	5
Tape Handlers			6	6

Above staffing is sufficient to operate:

1 705 II

2 720A Hi Speed Printers

1 Card to Tape

One operator and 2 tape handlers are used on the 705 at all times.

Methods of training used includes formal IBM classroom training (4 1/2 weeks) and approximately 2 years on-the-job training.

NSA

	One 8-Hour Shift
Supervisors	1
Librarians	1
Operators	1
Engineers	1
Technicians	1

Operation tends toward closed shop.

Methods of training used includes formal class and on-the-job training.

AT and T, LLD

	Two 8-Hour Shifts Used	Recommended
Supervisors	28	
Analysts	7	
Programmers	42	
Clerks	5	10
Librarians	3	3
Operators	5	5
In-Output Oper	8	8

Operators and system analysts are supervisors.

In-output operators and tape handlers are interchangeable.

Operation tends toward closed shop.

Methods of training used includes IBM schools and on-the-job training.

AT and T, TD

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors	2	3
Analysts, Prog. & Coders	7	
Librarians	1	1+
Engineers 16M	3	4
In-Output Oper & Tape Hand	4	6

Methods of training used includes IBM 705 Programmers School for a-b-c-d- above 1-i, plus console experience and programming. All others - on-the-job training.

Our training section intends to have one of our own people train our 705 people on our premises.

Boeing Wichita

	Three 8-Hour Shifts
Supervisors	5
Programmers	26
Librarians	5
Operators	6
In-Output Oper	7

Operation tends toward closed shop.

Methods of training used includes:

Machine Operators - IBM schools and on-the-job training

Programmers - IBM schools and special classes on programming and advanced languages conducted by company technicians.

Con Edison

	Three 8-Hour Shifts
Supervisors	10
Analysts, Programmers & Coders	22
Clerks	2
Librarians	2
In-Output Oper	19

Methods of training include IBM School and on-the-job training for programmers and on-the-job training for input-output operators.

Convair Fort Worth

	Three 8-Hour Shifts Used	Recommended
Supervisors	4	4
Analysts	4	9
Programmers	14	18
Librarians	1	2
Operators	7	9

Operation tends toward closed shop.

Esso Standard

	One 8-Hour Shift
Supervisors	8
Analysts, Prog. & Coders	20
Clerks (Scheduler)	1
Librarians (Tape)	1
Operators - 705	-
Engineers (IBM)	
In-Output Oper	25

Supervisors are for entire Data Processing and Programming Departments. There are 6 operators (705) and 6 IBM engineers for two 8-hour shifts. Tape handling is done by 705 operators.

Operation tends toward closed shop.

Programmers and 705 operators all given programming course by IBM. All other training done on the job.

Farmers IG

	One 8-Hour Shift
Supervisors	1
Analysts	2
Programmers	2
In-Output Oper	1
Tape Handlers	1

Operation tends toward open shop.

Firestone

	One 8-Hour Shift
Programmers	14
Engineers	4
In-Output Oper	5

Methods of training used include IBM Schools, UCLA, and AMA Seminars.

Ford Motor Man Ser

	One 8-Hour Shift
Supervisors	2
Analysts	7
Programmers	15
Operators	2
Engineers	3
In-Output Oper	4

Personnel requirements in our organization are based upon workload and the nature of the application. Two programmers, 2 operators, 2 engineers and 3 input-output operators are required in addition to the first shift shown for running three 8-hour shifts.

Operation tends toward open shop.

Ford Div

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Programmers	5	
Clerks	2	4
Librarians	1	1
Operators	2	2
In-Output Oper	1	1

One supervisor and 4 operators are used on the second and third 8-hour shift. Two additional input-output operators are recommended.

Operation tends toward open shop.

Hughes

	One 8-Hour Shift
Supervisors	6
Analysts	13
Programmers	18
Clerks	3
Operators	6

Eleven additional operators are required for two additional 8-hour shifts. A three shift total of 57 persons are used. Total figure includes clerical and staff. On-the-job training used.

Operation tends toward open shop.

It is necessary that operating personnel be familiar with all technical procedures of machine operation. Therefore, all personnel are trained as console operators, hence no figures are given for the in-output operator, tape handler, or technician classifications.

IH

	Three 8-Hour Shifts Used	Recommended
Supervisors	6	6
Analysts	2	2
Clerks	3	3
Operators Console	6	6
Engineers	5	5
In-Output Operators	11	11
Tape Handlers	6	6

Operation tends toward open shop.

Personnel are trained on the actual job. On-the-job training is supplemented by home study course on punched card equipment and by programming school for 705.

This operation serves as a service center. All programming is performed at other locations. Certain of the above personnel are engaged in systems and programming work but only for the internal operation of the computer center.

Illinois Central

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors		2
Analysts, Prog. Coders	9	
Operators		2
Engineers	3	
In-Output Operators		2
Tape Handlers		2

Operation tends toward closed shop.

McDonnell Aircraft

	One 8-Hour Shift
Programmers	35
Clerks	0
Librarians	0
Operators	2
In-Output Operators	2
Tape Handlers	0

One librarian is recommended. The second and third shifts use a total of 5 additional operators. Six are recommended.

3M

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors		2
Programmers	16	
Librarians	2	
Operators		12

Operation tends toward open shop.

Sandia Corp.

	First 8-Hour Shift	Second 8-Hour Shift	Third 8-Hour Shift
Supervisors	9	1	
Programmers	24		
Librarians	1	1	
Operators	2	1	2
In-Output Oper	5	2	

Analysis, programming, and coding is performed by one person classified as a programmer.

Operation tends toward open shop.

SOHIO

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	3	3	3
Anal, Prog. Cod.	22	22	22
Librarians	1	1	1
Operators	3	5	5
Engineers	5	5	5
In-Output Oper	1	1	1

One additional input-output operator is recommended.

Operation tends toward closed shop.

Texaco

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	1	1
Anal. Prog. Cod.	45		
Clerks	1	1	1
Librarians	1	1	1
Operators	4	7	8
Engineers	3	4	5

An additional clerk and a librarian are recommended.

Operation tends toward open shop.

Methods of training includes company operated computer schools, colleges, on job training. Personnel are normally selected from departments of the company.

USS TC and I

	One 8-Hour Shift Used	Recommended
Supervisors	4	4
Programmers	21	21
Clerks	4	4
Operators	3	3
Technicians	3	3
Tape Handlers	2	2

Operation tends toward open shop.

WE Hawthorne

	Two 8-Hour Shifts
Supervisors	10
Analysts	14
Programmers	19
Clerks	2
Operators	4
Engineers	20
In-Output Oper	4

Operation tends toward open shop.

Methods of training used consists of IBM 705 Programming School followed by on-the-job training under the guidance of experienced personnel.

WE Comp Methods

	One 8-Hour Shift	Total for Two 8-Hour Shifts
Supervisors	7	7
Analysts	26	26
Librarians	1	1
Operators	2	4
In-Output Oper	3	3

One additional supervisor and 1 additional input-output operator is recommended. Development personnel perform all functions of analyzing, programming and coding. There are three levels (tentatively identified as analyst, specialist, and coordinator) through which these personnel progress. All computer employees are classified as management personnel.

Methods of training used are IBM 5 week Programming School, and on-the-job training under IBM personnel and with our more experienced programming personnel and supervisors.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Naval Construction Bn Ctr

Average error-free running period 211.6 Hours
Good time 81.38 Hours/Week (Average)
Attempted to run time 81.59 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.9974
Above figures based on period 1 Dec 59 to 1 Jun 60
Passed Customer Acceptance Test 10 Mar 59
Time is available for rent to outside organizations.

An average of five hours nightly would be available for rent under present workload conditions.

Mare Island Naval Shipyard

Good time 95 Hours/Week (Average)
Attempted to run time 97 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period 1 Jul 60 to 31 Jul 60
Passed Customer Acceptance Test 3 Mar 58
Time is not available for rent to outside organizations.

USA TAGO

Good time 64.7 Hours/Week (Average)
Attempted to run time 71.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.91
Above figures based on period 1 Sep 59 to 29 Feb 60
Passed Customer Acceptance Test Mar 57
Time is not available for rent to outside organizations.

USA ABMA

Good time 108.7 Hours/Week (Average)
Attempted to run time 111.2 Hours/Week (Average)
Operating ratio 0.978
Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 13 Oct 58
Time is not available for rent to outside organizations.

USA EMC

Passed Customer Acceptance Test 8 Jul 57
Time is available for rent to qualified outside organizations.

Our 705 operation runs continuously from 7:30 A.M. each Monday through 7:30 A.M. the following Saturday. The 120 intervening hours are available for production runs with the following exceptions:

Each Tuesday and Thursday from 7:30 A.M. until 1:30 P.M. the computer is used to "debug" and test programs.

Each Tuesday and Thursday from 1:30 P.M. until 5:00 P.M. the computer is turned over to the IBM engineers for their preventive maintenance.

During the period of July 1959 through June 1960 breakdown time averaged 16.13 hours per month.

USAF Tinker AFB

534; 626; 0.85; 1 Apr 60 to 30 Apr 60; time is not available. Above computed on available time after maintenance down time.

USAF Tinker AFB

548; 579; 0.946; 1 Apr 60 to 30 Apr 60; time is not available. Above computed on available time after maintenance down time.

USAF ASO

208; 240; 0.84; 21 Mar 60 to 25 Mar 60; Sep 57; time is not available.

USAF ADC

74; 75; 0.988; 1 Jul 59 to 1 Jul 60; time is not available.

USAF SB AMA

The main frame acceptance dates for each of the IBM 705 systems were System No. 1 24 February 1958 and System No. 2 27 August 1959. Time is not available for rent to outside organizations.

USAF Olmsted AFB

75.8; 78.4; 0.97; Feb 60 to Apr 60; Feb 60; time is not available.

NSA

37.9; 38.2; 0.992; 1 Dec 59 to 31 Dec 59; time is not available.

AT and T, LLD

One hour; 55; 65; 0.85; Jan 60 to Mar 60; May 59; time is not available.

AT and T, TD

Passed Customer Acceptance Test Aug 58
Time is not available for rent to outside organizations.

Average monthly down time 12-18 hrs. (one shift basis) Dec. 59 - Mar. 60. Preventive maintenance time during working hours 3 to 4 hours/week. 705 main frame checked out each morning 7:30 - 8:30 before working hours.

Boeing Wichita
200; 240; 0.833 (2 systems); Jan 60 to Apr 60; 1st - 3 Sep 56, 2nd - 28 May 58; time is not available.
Convair Fort Worth
20.6; 93.1; 103.6; 0.90; 21 Mar 60 to 17 Apr 60; 18 Aug 58; time is not available.
Esso Standard
50; 59; 0.848; 1 Mar 60 to 31 Mar 60; Apr 56; time is not available.
Firestone

Good time	75 Hours/Week (Average)
Attempted to run time	75 Hours/Week (Average)
Operating ratio	0.994

Above figures based on period Jul 57 to Jul 60
Passed Customer Acceptance Test 17 Aug 57
Time is available for rent to qualified outside organizations. Time is available only to other 705II users under a Mutual Assistance Contract.
Ford Notor Man Ser

Average error-free running period	8 Hours
Good time	67.7 Hours/Week (Average)
Attempted to run time	87.1 Hours/Week (Average)
Operating ratio	0.77

Above figures based on period Jan 59 to Dec 59
Passed Customer Acceptance Test Mar 56
Time is available for rent to qualified outside organizations.
Ford Div
100; 50; 50.5; 0.993; Aug 59 to May 60; 31 Jul 59; time is not available.
Hughes
Building 105 System

Good time	376.19 Hours/Month (Average)

Above figure based on period 1 Feb 60 to 29 Feb 60
Passed Customer Acceptance Test Dec 56
Time is not available for rent to outside organizations.
Service Bureau System

Good time	242.25 Hours/Month (Average)

Above figure based on period 1 Feb 60 to 29 Feb 60
Passed Customer Acceptance Test Jun 59

A total of 149.1 hours of lost time was accumulated for both systems due to program failure, re-run time, operator error, and machine failure.
An additional down time for preventive maintenance of 62.8 hours and 106 hours for the two systems, respectively, was accumulated in February 1960.
IH

Good time	206.7 Hours/Week (Average)
Attempted to run time	230.1 Hours/Week (Average)
Operating ratio	0.895

Above figures based on period 1 May 60 to 31 May 60
Passed Customer Acceptance Test 15 Aug 57
Some time is available for rent if the time requested falls at times not required in order to meet our schedule. This is primarily over weekends and sometimes on Monday nights.
Illinois Central
7; 46; 53; 0.866; 1 Mar 60 to 31 Mar 60; 1 Oct 58; time is not available
McDonnell Aircraft
106.3; 114.4; 0.929; 4 Apr 60 to 30 Apr 60; Aug 57; time is available.
3M
65; 73; 0.89; Oct 56 to date; Nov 56; time is available at some periods of the month.
Sandia Corp.
141; 152; 0.93; Jan 60 to 31 May 60; 1 Aug 58; time is not available. Machine trouble for the past 3 months has been exceptionally high. Normally the operating ratio would be about 0.98.
SOHIO
105; 110; 0.955; 1 Jan 60 to 31 Mar 60; Aug 56; outside rental is available, dependent upon our schedules and size of job.
Texaco
15; 87; 93; 0.935; Jan 60 to Jun 60; Apr 57; time is not available.
USS TC and I
15; 52.6; 56.0; 0.94; 1 Apr 60 to 15 May 60; 1 Dec 56; Time is available depending upon availability of scheduling to meet requirements of outside organization.
WE Hawthorne
5; 61.8; 66.9; 0.93; 28 Mar 60 to 22 May 60; Sep 57; time is not available.
WE Comp Methods
67.58; 73.16; 0.92; 28 Dec 59 to 26 Jun 60; 14 Jan 58; time is not available.
Bilateral agreement with Esso Std. Oil, Bayway, N.J. Refinery, for reciprocal use of computer in case of machine breakdown.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
Special Representatives
This group offers overall consulting service in connection with the study of possible uses.
Educational Program
One-week classes conducted for executives at IBM educational departments in Endicott and Poughkeepsie, New York. Comparable classes are available in several major cities across the country. These courses are designed to acquaint executives with the organization, operating characteristics, capacities, and applications of the 705. Customers who complete this course are better able to evaluate the advantages, economics and wide business applications of the 705. In addition to the executive class, courses are available to qualified methods personnel. These classes are of longer duration and provide knowledge of programming and necessary operating details.
Programming Service
Personnel are available for consultation with field representatives and customers. A library of programs common to many problems is available for adoption as sub-routines by customer. Automatic coding as listed under automatic coding are available. Symbolic coding methods and assembly programs are available.
Sales Engineering
Engineers are available to assist in preparing the site for physical installation. This assistance begins twelve months in advance of delivery. Many systems have been installed.
Naval Construction Bn Ctr
Outstanding features are variable word length. Alphanumeric. Modular memory and input/output read while write and high speed rewind.
Unique system advantages include compatibility with other IBM systems. Generalized utility programs provided by manufacturer. Autocoder system for coding. Ability to have input/output devices on-line or off-line by merely flipping a switch.
Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage are: all tapes have internal and external labels. The internal label is automatically checked at the start of any program run. This also prevents writing on a tape that is not old enough to erase. A fireproof tape vault is provided with a capacity of over 3,000 tapes.

Mare Island Naval Shipyard

Outstanding feature is no special RPQ to equipment except on-line-off-line switch on card reader, as well as standard one on the control.

Internal program tape label control. Tape control (library) is on insert cards on tape case. Labelon used for temporary special identification. Separate storage of grandfather tapes and transaction tapes for emergency recovery. Tapes not normally shipped.

USA TAGO

All magnetic tapes are labeled with "Labelon" pressure sensative tape. Storage is accomplished in steel lock cabinets subject to the same temperature and humidity controls as the computer. Provisions for a tape vault are in the planning stage. Duplicate tapes are shipped to an alternate storage site packaged in the same manner as new tapes in order to permit file recovery in case of total site destruction.

A Taylor temperature-humidity recorder linked to an automatic audio-visual alarm system insures operation in the safe ranges of 60-80 degrees Fahrenheit and 40-60% relative humidity.

Employees are instructed in procedures designed to prevent damage to tapes and equipment in case of fire or other emergency.

USA ABMA

Outstanding features are read-while-write and variable length records.

External labels - pressure adhesive. Tape cabinet storage. Shipping - General Humidity: kept in computer room - fireproof building.

USA EMC

Magnetic tapes are labeled at the time of production, with a heavy paper label which fits into the slot provided on the reel. The tapes are stored in metal racks in a partitioned area of the computer room thus they receive the same protection as the computer itself.

USAF ASO

35 character identification record at beginning of each tape. "Labelon" tag on reel (written by operators). Tape library kept in humidity-temperature controlled room.

USAF ADC

Unique system advantage is that it provides efficient, effective and economical centralized control on command-wide applications.

Tapes are stored in the Tape Library in the air conditioned computer room. A separate master file of tapes is stored in a vault in another location for fire prevention. All tapes are labeled when used and a master file is maintained by Run Number and Tape Number.

USAF SB AMA

Outstanding features are flexibility of on-line data processing operation to handle a maximum of 26 input/output magnetic tape files in one computer system and 22 files in the second system.

Unique system advantages are that it permits the processing of data from source data to finished report on-line to conform to desired format and system is flexible to permit off-line simultaneous operations without committing the main frame.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire or other damage are:

Adequate fire protection measures such as automatic sprinkling systems, fire extinguishers and other devices are provided in readily accessible locations. In addition, fire prevention precautionary measures such as "no smoking" are enforced in proximity to magnetic tape files.

AMC Standard Utility Package label and file identification procedures are used on other than Advanced Logistics Systems. A file and label identification system specially developed for the Advanced Logistics System and an integral part of A.L.S. is used.

Contractor specifications are used as a guide for humidity and temperature controls in the operational phase of EDP.

A combined librarian-scheduling unit for expediting and synchronizing data flow with operational schedules provides internal managerial control of EDP operations.

AT and T, LLD

A unique system advantage is the variable word length.

Tape handling: Magnetic tape labels used, smoke detection devices used, operating areas isolated from each other by fire proof partitioning, remote storage of tapes, and alarms transmitted to remote 24 hour coverage for all important operating conditions.

AT and T, TD

Tape handling: Tape labeling - All tapes internally labeled before use, and external labels applied before each usage. Tapes in daily use stored in library in 705 room with humidity temperature and fire control systems. Tapes are rotated from permanent storage at a location away from New York on a quarterly basis. Shipping in metal fireproof boxes.

Boeing Wichita

Outstanding features are that the two 705 II systems are completely compatible and separated by a fire wall. This offers scheduling flexibility and partial backup in case of catastrophe.

Tape handling: Magnetic tape labelling used. Previous cycle master files stored in remote area for reconstruction if necessary. Tapes sealed in plastic for shipping or warehousing. Working files stored in metal cabinets in humidity and temperature controlled area. Smoke detectors installed. No sprinkler system.

Con Edison

Tape handling: Tapes kept in several storage rooms adjacent to but separated from the computers by suitable fire resistent walls. Mylar tape is used which does not require close humidity control.

Convair Fort Worth

Tapes stored in metal open racks in computer room under humidity and temperature control present in the room. Only fire protection available is that which is in stalled in computer room. Each reel of tape has a permanent number assigned and a temporary label for data stored on tape. Cross-reference Kardex ledger card kept for each reel of tape: 1 - by permanent reel number and 1 - job number (data stored on tape).

Firestone

No magnetic tape labelling. Humidity maintained at 40% - 60%, temperature at 70° to 75°. CO_2 fire protection in tape storage rooms.

Ford Motor Man Ser

All tapes are identified by number on the reel. Some applications use internal tape I.D. records. All tapes, with the exception of the master tapes, are filed in standard files in the computer room. The master tapes, 1050 reels, are stored in fireproof vaults (heat capacity of vault - 4 hours).

Ford Div

All input tapes and master tapes are stored in fire proof vault, excess are stored in computer room under humidity control. All tapes are given tape identification in the job program.

Hughes

Outstanding feature is that tape drives have illuminated dial setting display. A unique system advantage is the variable word length type system.

Tape containers stored in cement block fire-proof vault with constant humidity and temperature. External tape labelling system used.

IH

An outstanding feature is a switching device to switch on-line card header from one computer to the other.

All tapes are magnetically labelled and checked at the start of each job. Guides for tape changes and console operators are prepared mechanically from a deck of input-output data cards. Computer room controlled closely from humidity and temperature controls--no sprinkler system. Fire extinguisher conveniently placed and all personnel trained in their usage.

3M

Outstanding features are accuracy, speed, flexibility and variable length records.

Separate room for tape storage. S.O.P. to pull rings when job completed on CPU and only librarian puts them back on. Tapes held until output tapes are used in following job and it is completed and checked out.

Sandia Corp

A unique system advantage is the 705 Processor, with variable field length.

Tapes are stored in a vault, primarily for security, also for fire.

SOHIO

Outstanding features are variable word length core memory, full character representation for each memory position, and read-while-write feature.

We do not have any programmed tape labelling. Each tape used has an external label listing all necessary data (Input/Output of various programs, printing or punching, release dates, etc.). The entire computer room is controlled around the clock for both temperature and humidity. We have standby units in case of failure. We do very little shipping of tape, but if we do, they are packaged in the same container that they came in. For fire protection, we have very little burnable material in the computer room. Also we have a master key switch to turn off all power, and a fire hose.

WE Hawthorne

No magnetic tape labelling used. Tapes are stored in metal cabinets in an air-conditioned vault adjacent to the machine room. All areas are protected with a sprinkler system.

WE Comp Methods

Separate external reel labels for tape and data identification. Internal labeling for data identification and protection partially in use. Tape stored in open steel cabinets in separate library enclosed in 6 ft 6 in high steel and glass partitions, with fire resistant computer room. Tapes are not removed from computer room. Data on tape not sent out or received. Temperature and relative humidity consistently maintained at 75° and 50% respectively. Absolute limits: Temperature upper 80° lower 50°. Relative humidity upper 60% lower 40%. Smoke alarm in return air duct terminating in IBM customers engineers room and Plant Fire Headquarters. Portable CO_2 extinguishers installed ar frequent intervals around perimeter of room.

FUTURE PLANS

Manufacturer

There is growth upwards from the 705 with complete program compatibility to the 7080 Data Processing System.

Naval Construction Bn Ctr

In the proposal stage is a plan to install an IBM 1401 Data Processing System to replace the Type 774 Tape Data Selector and the Type 607 Electronic Calculator at a net savings to the government. This will provide more computing capacity and faster off-line operations at reduced cost.

Mare Island Naval Shipyard

IBM 1401C with 1402, 1403 and one 729 on order to replace 720 Printer.

IBM 1401C with 1402, 1403 and two 729 requested (now pending) to replace card reader, punch and EAM equipment and intended to divert from 705 some of smaller jobs.

Preliminary review for replacement with solid state machine. Primary reason being increased capacity and speed at lower rentals on newer computers. No determination made as to replacement machine or date of replacement.

USA TAGO

Add an IBM 1401 complex to replace peripheral output equipment.

USA EMC

EMC forwarded to higher authority a justification for acquiring IBM 1401 Data Processing Equipment. This equipment was justified promarily on the basis of its replacing certain IBM 700 series equipment used for card reading, punching, and printing. The requested equipment operates at much faster speeds than the presently used equipment, has 4000 positions of core memory, and rents for nearly $500 less per month.

The IBM 1401 equipment requested consists of:

1	1401/C3	Processing Unit
1	1402/1	Card Read Punch
1	1403/2	Printer
4	729 II	Tape Units

The IBM 1401 Processing Unit will be equipped with four special devices which provide for high-low-equal compare, multiply-divide, print storage, and advance programming. In addition, we have requested the IBM 705 II Central Processing Unit be modified to provide for reading cards directly into memory.

The present IBM 700 series equipment to be released when the IBM 1401 equipment becomes operational is as follows:

2	717	Printers
2	757	Printer Control Units
1	722	Card Punch
1	758	Card Punch Control Unit
1	714	Card Reader
1	759	Card Reader Control Unit
1	727	Tape Unit

In our development of projects for ADPS applications we will determine whether they can best be performed on the IBM 1401 equipment or the IBM 705 II, and will program the application for the appropriate equipment.

We are currently studying all large scale computers in regard to our projected workload requirements for EMC and the recently announced single manager mission for military construction supplies. It is anticipated that these studies will result in a justification for computer equipment of much greater capacity than we are presently using. These studies will probably be completed by the first of next year.

USAF ASO

2 IBM 705 Mod III Systems, each with 16-729 Mod III Tape Units and 3 IBM 1401 Mod C Systems each with 3-729 Mod IV Tape Units will replace the present equipment.

USAF ADC

The acquisition of a IBM 1401 is planned. This will replace the 720 Printer and Card Punch now in use.

USAF SB AMA

IBM 1401 Computer Systems are scheduled to be acquired at Norton AFB. These are to be used in conjunction with the IBM 705 Systems to relieve the large scale computers of the less involved processing, particularly in editing and sorting operations. In addition, this equipment will replace peripheral items such as tape data selectors and printers.

Future developments involving EDPE in AMC activities are generated at Hq AMC, Wright-Patterson AF Base, Dayton, Ohio.

USAF Olmsted AFB

Following programs will be implemented:

Weapon System Stock Control and Distribution, Prime Class Stock Control and Distribution

Air Vehicle Configuration Status

AT and T, LLD

Magnetic tape to magnetic tape transmission.

IBM 1401 to replace peripheral equipment.

IBM 1401's to remote locations tied to central data processing center by magnetic tape-to-tape transmission.

AT and T, TD

Replace present 705 II with 705 III with 729 III high speed tape drives.

Replace present 720A's (3) and 730 (1) printer with four (4) 1401 systems.

Boeing Wichita

Plan to replace two 705 II Systems with one 705 III System, with drum, 80K memory, two DSU's and twenty tape drives.

705 auxiliary equipment will be replaced with 1401 Systems by early 1961.

Hope to reduce to 14 tape drives on-line by file grouping output for processing on 1401 Systems.

Considering a low speed, low priced RPQ "on-line" card input device for use with 705 III to replace Type 714 Card Reader.

Con Edison

Changing main frames from 705 Model II to 705 Model III in June and July 1960.

IBM Model 1401 printer punches to replace most of present peripheral equipment.

Convair Fort Worth

New equipment plans

Install 2 IBM 1401-C3 Systems to replace:

1 Card Punch
1 Card Reader and Control Unit
2 150 lines/min printers and control units
1 500 lines/min printer and control unit
1 Tape Data Selector and power unit

Install 1 IBM 7080 Computer to replace 1 IBM 705 Computer.

Esso Standard

We have on order two IBM 1401 Tape Systems. These systems will be used for our smaller computer jobs, and for processing input and output in support of the 705 System. This will permit release of most of our 700 series peripheral equipment and some of our EAM (punched card) equipment.

Firestone

All peripheral off-line equipment to be replaced with 2 1401 complexes consisting of:

1 1401
1 1402
1 1403
2 729 II

Ford Motor Man Ser

Our present plans call for exchange of all auxiliary equipment and replace it with 2 1401 Systems.

Ford Div

Planned replacement of present peripheral equipment with two IBM 1401 installations. Also, considering replacement of existing 705 when capacity utilization makes replacement necessary.

As to prospective applications, new applications are being built principally in the sales and manufacturing area. These will include analysis of sales data, forecasting of vehicle options and accessories, maintenance of master bills of material, and related computer applications.

Hughes

Integrated systems study now being formalized. (A data processing system has not been chosen as yet).

Consideration is being given for replacement of existing peripheral equipment (card punch, printer, and card reader) with IBM 1401 Tape System.

RAMAC (305) will be installed at El Segundo Plant Site to handle manufacturing production requirements. (Scheduled for mid-summer).

EAM projects, in corporate areas, are being converted to the 705 Data Processing System.

Convert existing 705 Model I System to 705 Model II System.

Hughes

Installation, by lessor, of a 5,000 KVA transformer to stabilize line transients.

IH

We have proposed the replacement of the 2 705 Systems by one 7080 System. Also our three printers stations, one card-to-tape station, and one tape-to-card station are to be removed and replaced by 3 of the 1400 series systems.

Anticipated applications to be added are:

Credit and Collections
Machine loads
Monthly works costing and closing

Illinois Central

IBM Model 7080 to replace existing equipment.

3M

Three (3) Type 1401 Systems are on order. Various projects underway to fill up available time on the computer.

Sandia Corp.

It is anticipated that the 705 II will be replaced with a 7090 and two (2) 1400's.

New applications:

Personnel, Tool Accountability, Budget, and Parts List

SOHIO

Equipment

Replace Model II 705 with a Model III 705.

Replace independent equipment, for 705 System, and tabulating EAM equipment with three 1401 Systems.

Replace 705 Model III System with a 7080 System by end of 1961. This is to handle expected increase in load.

Systems and Production Plans

Purchasing, payroll and manpower statistics, retail billing, yield accounting, inventory control, stockholder accounting, property accounting, general accounting, refinery scheduling, pipeline scheduling, forecasting (various functions), and linear and nonlinear programming.

Texaco

Install IBM 7090 with 16 789 IV tapes on line.

Install 5 IBM 1401 Systems in Houston, 1 in Los Angeles, 3 in New York, and 2 in Chicago.

Release present 705 and peripheral equipment following checkout of above 7090 System.

WE Hawthorne

The present IBM 705 II EDPM will be replaced with an IBM 705 III. Only the magnetic drum and the card reader along with their respective control units will be retained. In addition, the auxiliary equipment consisting of 3 printers, a card reader, a card punch, and several tape units will be replaced by two IBM 1401 C EDPM's and one IBM 1401 D EDPM.

WE Comp Methods

Orders were issued for replacement of present 705 Mod. II and drum with IBM 705 Mod. III with 80,000 core storage. Also to replace present peripheral equipment with three IBM 1401 Systems except one Type 714 Card Reader will be retained for "on-line" use - new system will use high speed - high density type 729 tape units.

Other areas planned for future computer processing include:

Inventory control, stock record keeping, equipment and component shop ordering, customer engineered order editing and entering, shop accounting, wage incentive crediting, and customer contract preparation and billing.

INSTALLATIONS

U. S. Naval Construction Battalion Center, Port Hueneme, California

Mare Island Naval Shipyard, Mare Island, California

U. S. Army, The Adjutant General's Office, The Pentagon Building, Washington 25, D. C.

U. S. Army Ballistic Missile Agency, Bldg. 4663, Redstone Arsenal, Alabama

U. S. Army Engineer Maintenance Center, 52 Starling Street, P. O. Box 119, Columbus 15, Ohio

U. S. Air Force Headquarters, OCAMA, Tinker Air Force Base, Oklahoma (2)

U. S. Air Force Aviation Supply Office, 700 Robbins Avenue, Philadelphia 11, Pennsylvania

U. S. Air Force Headquarters, Air Defense Command, Ent Air Force Base, Colorado Springs, Colorado

U. S. Air Force San Bernardino Air Materiel Area, AMC, Norton Air Force Base, California

U. S. Air Force Headquarters, MAAMA, Olmsted Air Force Base, Pennsylvania

National Security Agency, Fort George G. Meade, Maryland

American Telephone & Telegraph Company, Long Lines Department, Mt. Kisco, N. Y.

American Telephone & Telegraph Company, Treasury Department, 50 Varick Street, New York, New York

Boeing Airplane Company, Wichita Division, Wichita, Kansas

Consolidated Edison Company of New York, Inc., 4 Irving Place, New York 3, New York

Convair, A Division of General Dynamics Corporation, Fort Worth, Texas

Esso Standard, Division of Humble Oil & Refining Company, Baton Rouge Refinery, P. O. Box 551, Baton Rouge, Louisiana

Farmers Insurance Group, 4680 Wilshire Blvd., Los Angeles, California

The Firestone Tire & Rubber Company, Akron 17, Ohio

Ford Motor Company, Computer Services Department, Room 1109, Rouge Office Building, Dearborn, Michigan

Ford Division of Ford Motor Company, Rotunda & Southfield, Dearborn, Michigan

Hughes Aircraft Company, Industrial Dynamics - General Offices, Florence Avenue & Teale Street, Culver City, California (2)

International Harvester Company, 180 North Michigan Avenue, Chicago 1, Illinois

Illinois Central Railroad Company, 135 E. 11th Place, Chicago 5, Illinois

McDonnell Aircraft Corporation, Box 516, St. Louis 66, Missouri

Minnesota Mining and Manufacturing Company, 900 Bush Avenue, St. Paul 6, Minnesota

Sandia Corporation, Electronic Data Processing Department 3450, Sandia Base, Albuquerque, New Mexico

The Standard Oil Company (Ohio), Midland Building, Cleveland 15, Ohio

Texaco, Inc., Data Processing Division, P. O. Box 2332, Houston 1, Texas

Tennessee Coal and Iron Division, United States Steel Corporation, P. O. Box 599, Fairfield, Alabama

Western Electric Company, Inc., Hawthorne Works, Hawthorne Station, Chicago 23, Illinois

Western Electric Company, Inc., Computer Methods, 100 Central Avenue, Kearny, New Jersey

U. S. Air Force, Headquarters Mobile Air Materiel Area, Brookley Air Force Base, Alabama

Harvard University, Littauer Statistical Laboratory, 94 Prescott Street, Cambridge 38, Massachusetts

Prudential Insurance Company of America, Home Office, Newark, New Jersey

U. S. Air Force Mobile Air Materiel Area, Brookley Air Force Base, Alabama

IBM 705 III

IBM 705 III Data Processing System

MANUFACTURER

International Business Machines Corporation

Photo by International Business Machines Corporation, Products Development Laboratory

APPLICATIONS

Manufacturer

This is a general purpose computer for both scientific and commercial applications. The system is commercially oriented with Applied Programming Packages very prominent in this area.

U. S. Army Signal Supply Agency

Located at 225 S. 18th Street, Philadelphia, the system is used for inventory control of 200,000 Signal Corps items, requisition processing and stock distribution, procurement status and allotment accounting, preparation of catalogs, computation of requirements, and managerial reports such as budget estimation.

U. S. Navy Ships Parts Control Center

Located at Mechanicsburg, Pa., one of the major uses of the electronic data processing system is the maintenance of perpetually current inventory records for approximately 135,000 items of ships repair parts. Master inventory records are updated through the media of transaction reporting cards received from twenty reporting activities. The transaction reporting system was implemented shortly after installation of the EDPS in August 1956. An analysis of items having experienced any type of action during the current week provides the tool for improved stock positioning and more effective management control. The machine is also being used to develop component and item population data; in the preparation of Shipboard Allowance Lists; budgeting and inventory analysis and in the automatic maintenance of voluminous technical engineering data files.

U. S. A. F. Wright-Patterson AFB, Ohio

Located at the Statistical Services Division, the system is used for Hq AMC cataloging and standardization.

This application combines cataloging and standardization to accomplish the following objectives:

Prescreen all contractor-recommended items prior to contractor's preparation and submission of provisioning documentation etc., to the Air Force end article prime depot. Results of prescreening function will validate, reject, or correct stock numbers submitted by the contractor with part-number data for prescreening, furnish the contractor with the known stock numbers for items submitted for pre-

Photo by International Business Machines Corporation, Products Development Laboratory

screening, furnish the contractor with the stock number and electrical accounting machine (EAM) identification data for each Federal item of supply to which a part number is referenced when the part number submitted for prescreening is referenced to more than one Federal stock number (FSN), isolate each part number submitted for prescreening that is not indexed to an existing stock number in the master files, and provide a printout product that will constitute an order to ship specific description patterns to the contractor.

Screen items for AMC components by Federal supply class (FSC), by item name; by manufacturer's code; by FSN; or by part number. Results of this screening will provide EAM cards and/or EAM listings-products to be determined upon the specific request for screening.

Compile data for publication of Air Force master cross-reference indexes S-00-1-1, "Part Number to Federal Stock Number," and S-00-1-2, "Federal Stock Number to Part Number." Each of these publications is to be compiled annually, and their addenda, quarterly, if required.

Compile data for publication of management data count reports of items and stock-control data elements on FSC group basis and on FSC group and class basis, as well as on management-code basis.

Provide products for use in management by exception situations; e.g., list Federal data that have been in the master files for more than 2 months without stock-control data, list stock-control data for which Federal data are not in the master files, and list stock-control data cards that contained error when received.

Additionally, this system supports the AMC centralized data development function in the preparation, testing, debugging and operational simulation of data systems prior to command implementation.

Air Weather Service Climatic Center

Located in the Grove Arcade Building, Asheville, North Carolina, the system is used for the processing of weather data.

Social Security Administration

Located in the Social Security Bldg., Woodlawn, Baltimore 35, Maryland, the system is used for maintenance of social security accounts, establishment of new accounts, identification of incorrectly reported account numbers, tape search for summary earnings records of accounts involved in claims, selecting addresses from master tape and addressing correspondence, compilation of statistical tables, and computation of old-age, survivors, and disability benefits.

Veterans Administration

Located at Hines, Illinois, the system is used in currently maintaining the payment, accounting, and statistical records for payment of compensation and pension to veterans and other beneficiaries.

U. S. Dept. of Agriculture, Commodity Stabilization Service

Located at New Orleans, Louisiana, the system is used

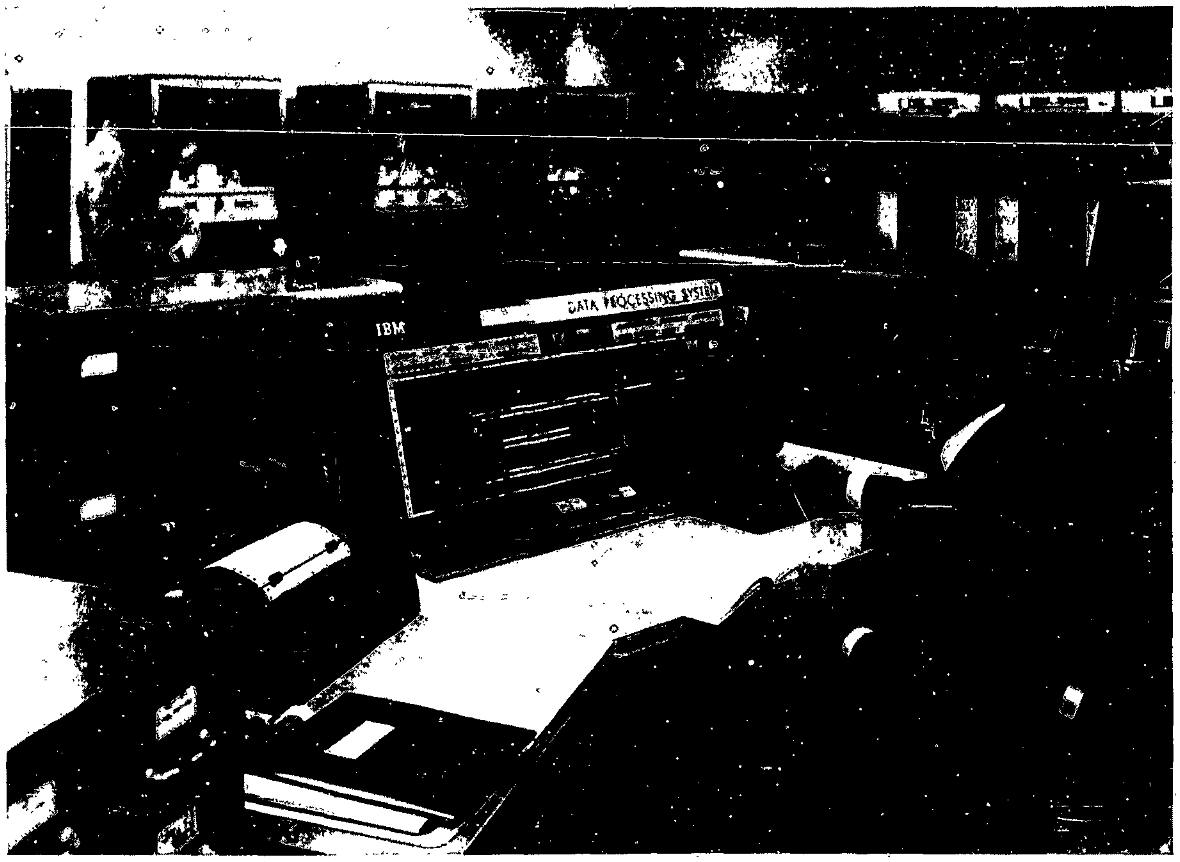


Photo by International Business Machines Corporation, Products Development Laboratory

for processing cotton price support loan and purchase program transactions: This embraces loan making and liquidation, reconcentration, and producer settlements consisting of approximately 9 million bales per year.

Cotton inventory management: This includes the maintenance of inventory control acquisitions, maintenance and disposition of CCC owned cotton. Accordingly, payments to warehousemen for storage and services, payment to railroads for transportation and handling. Sales and other dispositions are included as a part of this application. These records serve operational, accounting, budgetary, and general management needs on an integrated basis. The inventory consists of approximately 1.3 million bales records.

Acreage reserve sight draft application: This involves maintaining accountability on national basis for the acreage reserve sight drafts. Approximately 500,000 drafts per year.

Dairy herd improvement application: This consists of keeping records of the geneology of dairy herds as a study of improving breeding. The study involves in excess of 2 1/2 million records.

Grain inventory warehouse receipt application for the Dallas CSS Commodity Office: The Dallas Commodity Office is an area grain office which utilizes the New Orleans computer on a data processing center basis for this application. This includes the maintenance of warehouse receipts representing price support grain inventory which are in storage, in inland warehouses and the related issuance, loading orders, and blending of grain through the use of linear programming techniques.

Commonwealth Edison Company, Chicago

Located in Room 441, Commonwealth Edison Company, 72 W. Adams St., Chicago, Illinois, the system is used for customer billing and accounting, property records accounting, various engineering applications, extraction of data from master customer file tapes, upon request, for various special reports, and extraction of customers' names and addresses, upon request, for special mailings to customers.

Commonwealth Edison has approximately 2,000,000 customers who are in the most part billed bi-monthly. We have a 7 day cycle on the computer wherein each day, file maintenance is performed on approximately 300,000 accounts, 50,000 meter readings are posted, 50,000 bills are produced, cash is posted to approximately 50,000 accounts and customer account reference listings are produced to provide current information for use by our customer contact people.

Eastman Kodak Company

Located at Rochester, New York, the system is used for customer billing, accounts receivable, sales reporting, scientific computing, payroll, inventory control (finished goods), production planning and scheduling, and cost accounting.

IBM Methods

Located at the IBM Mfg. Plant, Poughkeepsie, N. Y., the system is used for payroll, labor and burden, general accounting, budgets, property record account-

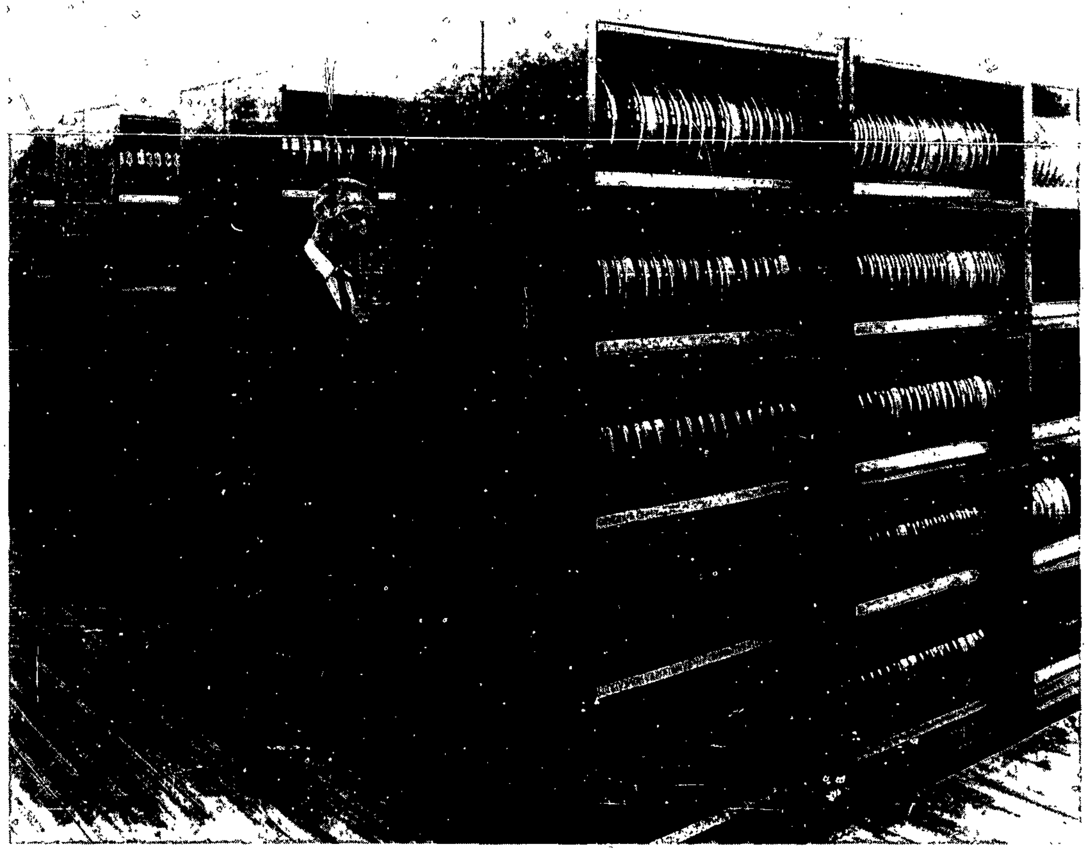


Photo by International Business Machines Corporation, Products Development Laboratory

ing, production performance, cost accounting, personnel, accounts payable, inventory control, manufacturer's planning, long range load, quality control, and requirements generation.

International Harvester Co., Motor Truck Div. Located on Meyer Road, Fort Wayne, Indiana, the system is used for:

Payroll - calculation of gross wages and associated labor distribution; development of net wages and preparation of pay drafts; accumulations for quarterly and annual state and federal reports.

Material Requirements - explosion of monthly production forecast to piece part level; all requirements are accumulated by part number and adjusted for lead time, inventory, scrap, and production breaks. For manufactured parts, raw and bulk material requirements are calculated; for purchased parts, vendor records are prepared. During the month if gross requirements equal or exceed 20% of the bank, the necessary modification documents are prepared.

Vendor Release - adjust purchase order tape developed from material requirements for percentage split between vendors as specified. Using the adjusted purchase order tape, establish lot buy quantities and price differential quantities, and develop resulting vendor schedule for delivery and fabrication.

District Office Property Accounting - maintain inventory of trucks at company owned district offices. Prepare monthly statements of sales and inventory status. Prepare monthly and quarterly listings for districts of chassis in their inventories. Develop sales statistics and lists of trucks available for transfer.

Production Progress - maintain perpetual status of units built, open orders and scheduled for production. Daily built statistics provide the basis for calculating line labor pay. Each month, the production forecast is developed mechanically from statistics contained in these records. During the month, as required, an analysis is made of built, slotted orders, and forecasted schedules to determine if a forecast revision is necessary.

Costing Applications - maintain parts master records with all necessary cost factors and statistics. Calculate market and average costs for both manufactured and purchased parts and assemblies; summarize to develop a prime cost for each component unit of a truck. These costs are used to cost accumulative production and to value sales and inventory by year of production. By applying adjustments to costs as developed, calculate amounts to be used in determining sales prices.

Stock Status of Major Components - develop a daily inventory of major component parts and assemblies by processing receipts, disbursements, and miscellaneous adjustments with previous balance records. Also, anticipated production for the next 5 days is exploded to show probable conditions for that period.

Photo by U. S. Department of Health, Education and Welfare

Line Stocking - explode the production anticipated for the fifth day hence; combine with previous balance records to prepare a list showing the part number requirements for next 5 days by assembly locations.

Engineering Calculations - engineering work encompasses several phases. In the research area we do calculations involving gear ratio, torque conversion and bearing load analysis. Some calculations actually design such units as camshafts and drive lines. Still other computations may be classified as data reduction and involve performance study and stress analysis. In the record keeping category a weekly analysis is prepared on time spent on assigned projects.

Westinghouse Electric Corporation

Located on Sharpsville Avenue, Sharon, Pa., the system is used for manufacturing information, engineering design and drafting, industrial engineering, production scheduling and factory loading, finished goods and raw material control and purchasing, manufacturing cycle efficiency and production material control, factory expense and budget statements, hourly and salary payroll and industrial relations statistics, material layout and scrap loss reduction, and sales statistics.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system Binary Coded Alphanumeric
Alphanumeric char/word Variable

The 705 is not a fixed word length system. It is possible to have both variable field and variable record lengths. There are no words, each character of a record being individually addressable.

Alphanumeric char/instruction 5
Instructions decoded 51
Arithmetic system Fixed point

Floating point is programmable.

Instruction type One address
Number range $-10^{255} < m < 10^{255}$
Instruction word format

Oper				
	Address with zone bits as indicators			

Automatic built-in subroutines include store-for-print and transmit.

Automatic coding: 705 Processor including Autocoder III, file maintenance and report/file writing, decision making and Fortran.

This is a programming system which will translate programs written in any one or a combination of the following service languages into object programs in

Photo by U. S. Department of Health, Education and Welfare

actual machine language.

Autocoder III

An advanced programming language in which programs may be written by stating the data processing involved.

File Maintenance and Report/File Writing

A specially designed language, the use of which enables a programmer to express the specifications for a report and/or a file in a simple set of statements.

Decision Making

A specially designed language, the use of which enables a programmer to express the conditions required for making a decision, in simple concise statements.

Fortran

A programming language in which a scientific problem can be expressed in statements closely resembling the language of mathematics.

Registers and B-boxes include one 256 character accumulator, 14 auxiliary storage units (16 characters each), and one auxiliary storage unit (32 characters).

ARITHMETIC UNIT

	Incl Stor Access Microsec	
Add 6+6	95.8	(6 digits added to 6 digits)
Mult 6x6	770.8	(6 digits times 6 digits)
Div 10/6	3159.2	(6 digits divided by 6 digits)

Multiply time $= 58 + N_s\ (63 + 9.3N_M)$

where N_s = Number of digits in Multiplier

N_M = Number of digits in Multiplicand

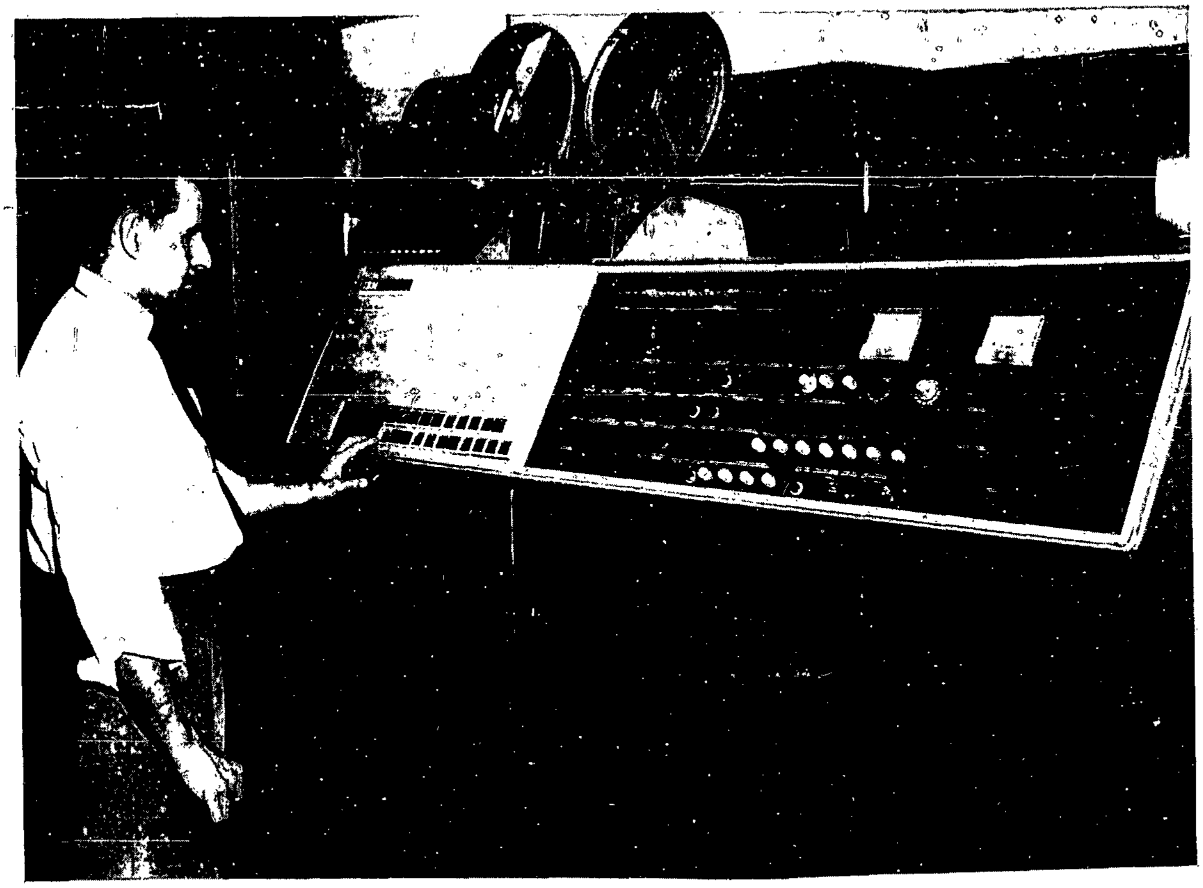
Divide time $= 90 + 9N_s + 9(N_s - N_m)(6.7N_m + 37)$

where: N_s = Number of digits in dividend

N_m = Number of digits in divisor

Construction (Arithmetic unit only)

Vacuum tubes	> 2,100	
Transistors	0	
Condenser-diodes	> 6,900	
Magnetic cores	> 3,500	
Arithmetic mode	Serial	
Timing	Synchronous	Central Processing Unit
	Asynchronous	Input, Output Devices
Operation	Sequential	Central Processing Unit
	Concurrent	Simultaneous reading, writing and computing are possible.



IBM Tape to Microfilm Printer — Photo by U. S. Department of Health, Education and Welfare

STORAGE

Manufacturer Media	No. of Char	Access Microsec
Core	40,000 or 80,000	9.3
Magnetic Drum	Up to 100 drums 60,000 char each	8,000
Magnetic Tape	> 14,000,000 char/reel	7,300

No. of units that can be connected	60	Units
No. of char/linear inch	200 or 556	Char/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating each record	0.75	Inches
Tape speed	75 or 112.5	Inches/sec
Transfer rate	15,000;22,500;41,667;62,500	Char/sec
Start-stop time	10.8 or 7.3	Millisec
Average time for experienced operator to change reel	60	Seconds
Physical properties of tape		
Width	0.5	Inches
Length of reel	2,400	Feet
Composition	Mylar	

Mylar is DuPont's trademark for its polyester film.

USA SSA

40,000 alphanumeric character magnetic core memory, each character separately addressable; 60,000 character magnetic drum; magnetic tape.

USN SPCC

40,000 character magnetic core; 19 magnetic tape stations.

USAF W-P AFB

40,000 MC; 60,000 MD; 18 MT

Average access time to magnetic drum is such that the first character is available in 8 milliseconds; subsequent characters, in sequence, are each available in 40 microseconds.

AWS CC

Media	No. of Alphanum/Char	Access Microsec
Magnetic Core	40,000	13
Magnetic Tape	5,760,000	10,000+67 n/char
	16,012,800	7,500+16.5 n/char

Magnetic tape storage consists of Type 729 Model I and Model III tape drives.

Social Security

40,000 MC; MT

VA

80,000 MC; MT

USDA CSS

80,000 MC; 16 MT

Commonwealth Edison

40,000 MC; 60,000 MD; 13 MT

Eastman Kodak

40,000 MC

IBM Methods

80,000 MC; MT

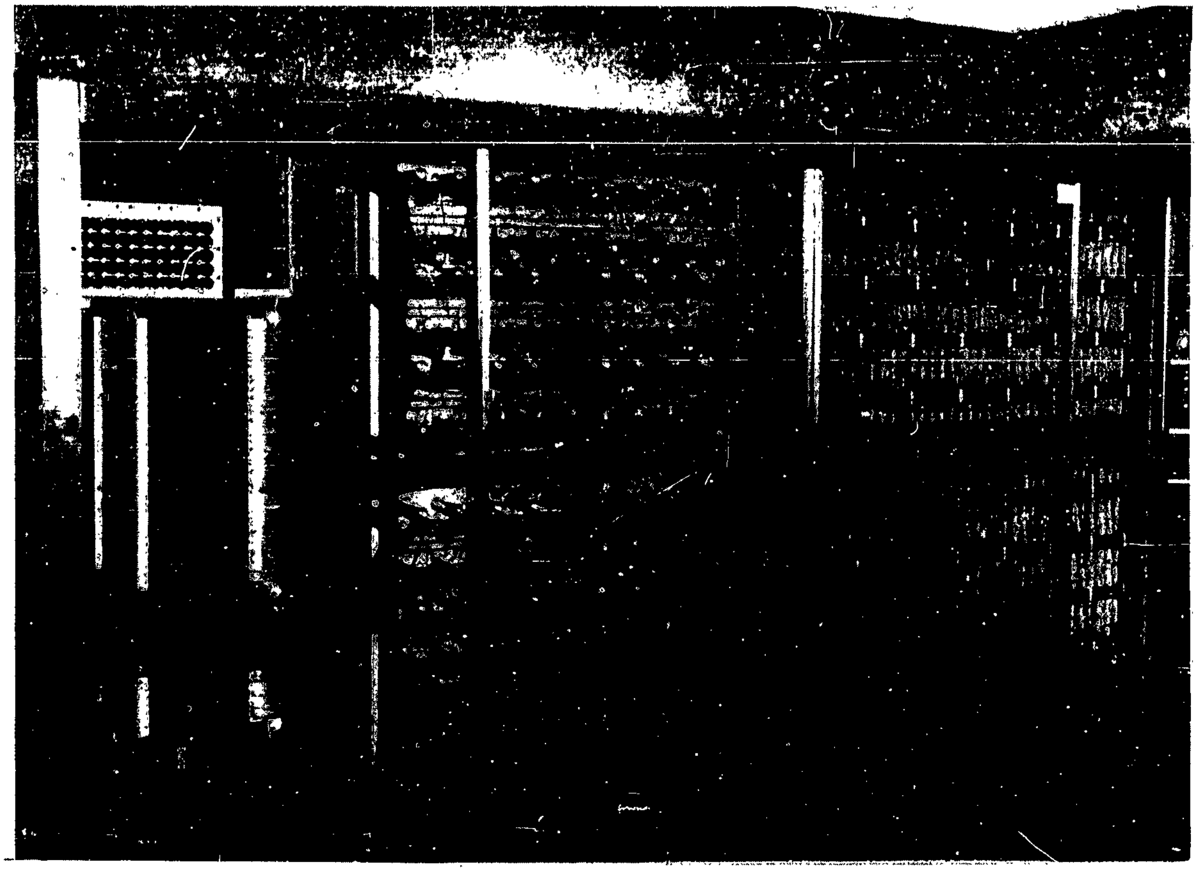


Photo by U. S. Department of Health, Education and Welfare

International Harvester
40,000 MC; MT
Westinghouse
40,000 MC; 60,000 MD; MT

INPUT

Manufacturer

Media	Speed
Magnetic Tape	See above
Card	250 cards/min
Operator's Console	Manual
Magnetic Drum	25,000 char/sec

USA SSA
Magnetic Tape and Cards
USN SPCC
One Card Reader and Control Unit
Eight 729 Model I Tape Units
Eight 729 Model III Tape Units
Three 727 Tape Units
USAF W-P AFB

Media	Speed
18 Type 727 Tape Units	15,000 char/sec
1 Type 714 Card Reader	240 cards/min

Sixteen tape units are on line, 2 are off line. Buffering between tape units and magnetic core memory is provided by 2 Type 777 Tape Record Coordinators. In addition, a Type 754 Tape Control Unit is on line for control of a maximum of ten Type 727 Tape Units.
AWS CC
Magnetic Tapes and Punched Cards
Social Security
Punch cards converted to tape in off-line operations.
VA

Media	Speed
Card Reader	250 cards/min
Card Image Tape	15,000 char/sec
Lo Speed Tape	15,000 char/sec
Hi Speed Tape	62,500 char/sec

USDA CSS
1 714 Card Reader
1 759 Card Reader Control
8 729 I Tape Units
8 729 III Tape Units
2 767 Tape Data Synchronizers
Above units are on line
Commonwealth Edison
Punched Cards and Magnetic Tape
Eastman Kodak
IBM 714 Card Reader 200 cards/min
IBM Methods
Magnetic Tapes and Punched Cards
International Harvester

Magnetic Tape	75 in/sec	Card to tape detail
Magnetic Tape	112.5 in/sec	Previous balance records

Photo by Eastman Kodak Company

Westinghouse

Medium	Speed
Magnetic Tape	15 char/sec

OUTPUT

Manufacturer

Media	Speed
Magnetic Tape	See above
Card	100 cards/min
Printers	150, 500, 1,000 lines/min
Typewriter	600 char/min
Magnetic Drum	25 char/sec

In addition to the above components, an IBM 1401 Data Processing System may be used for peripheral operations. The speeds of the 1401 components are:

Card Reading	800 cards/min
Card Punching	250 cards/min
Printer	600 lines/min

The tapes from the 705 III are completely compatible with the 1401 System.

USA SSA

Magnetic Tape, Cards and High Speed Printer

USN SPCC

One Type 720 Printer and one Type 760 Control Unit (500 lines per minute)

One Type 717 Printer and Control Unit (150 lines per minute)

Eight 729 Model I Tape Units

Eight 729 Model III Tape Units

Three 727 Tape Units

One Card Punch and Control Unit

USAF W-P AFB

Media	Speed
2 Type 717 Printer	150 lines/min
1 Type 722 Card Punch	100 cards/min
Magnetic Tape	15,000 char/sec

The printer and punch are used off line only normally.

AWS CC

Magnetic Tape	15,000 char/sec
	62,500 char/sec
Card Punch	100 cards/min
Printer	150 lines/min

120 print positions

Magnetic tape output consists of Type 729 Model I and Model III tape drives.

Social Security

Magnetic tape converted to printed copy, microfilm and punched cards in off-line operations.

VA

717 Printer	150 lines/min
Lo Speed Tape	15,000 char/sec
Hi Speed Tape	62,500 char/sec
Card Punch	100 cards/min

Photo by International Business Machines Corporation, Methods DS Manufacturing

USDA CSS

One 717 Printer
One 757 Printer Control
Eight 729 I Tape Units
Eight 729 III Tape Units
Two 767 Tape Data Synchronizers
Two 748 Tape Data Synchronizer Power
One 722 Card Punch
One 758 Card Punch Control
Above units are on line
Two 714 Card Readers
Two 759 Card Reader Controls
One 722 Card Punch
One 758 Card Punch Control
Three 729 Printers (500 lines/min)
Three 760 Printer Controls
Seven 729 I Tape Units

Commonwealth Edison

Media	Speed	
Magnetic Tape	75 in/sec	IBM 727 Tape Units
Punched Cards	100 cards/min	IBM 722 Card Punches
Printer	500 lines/min	IBM 720-2-Printers

13 IBM 727 Tape Units connected to main frame.
All card to tape, tape to card, and tape to printer operations are off-line. Tape density is 200 char/inch.

Eastman Kodak

IBM 722 Card Punch	100 cards/min
ANelex Printers	667-1,000 lines/min

Purchased 1960

IBM Methods

Magnetic Tapes, Punched Cards, and 150 lines/min Printer

International Harvester

Magnetic Tape 75 in/sec
Report tapes or tapes-to-card records
Magnetic Tape 112.5 in/sec
Balance forward tapes for additional processing
In one case, where the small number of cards to be punched does not restrict computer operations the punch is connected to the main line and cards are punched during the processing.

Westinghouse

Magnetic Tapes 15 char/sec
Off-line card to tape, tape to punch and tape to printer.

CHECKING FEATURES

Manufacturer

Character code check on internal operations and data transmission; sign check for arithmetic instructions; overflow; character code check during transmission from storage to I/O units; horizontal and vertical parity check on magnetic tape; dual level sensing; two gap head for verification of tape writing; two read stations in card reader; echo checking on line printer; row-count comparison in card punching.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	145.1 KVA
Weight, computer	39,815 lbs

Physical planning manual is available.

USA SFA

Power, computer	138 KVA 120/208V - 4 wire
Volume, computer	23,400 cu ft
Volume, air conditioner	6,000 cu ft
Area, computer	2,600 sq ft
Area, air conditioner	500 sq ft
Room size, computer	40 ft x 65 ft
Room size, air conditioner	25 ft x 20 ft
Floor loading	1,000 point load
Capacity, air conditioner	40 Tons
Weight, computer	39,355 lbs
Weight, air conditioner	18,000 lbs

First floor location prepared with false ceiling and raised floor. Air conditioning equipment is located approximately 50 feet from the computer room. Building modification cost about $100,000 and air conditioning $75,000. Power is supplied by an air core transformer used exclusively for the computer.

USAF W-P AFB

Power, computer	164.9 KVA
Volume, computer	25,280 cu ft
Volume, air conditioner	3,200 cu ft
Area, computer	2,939 sq ft
Area, air conditioner	320 sq ft
Room size, computer	60 ft x 49 ft
Room size, air conditioner	20 ft x 16 ft
Floor loading	250 lbs/sq ft
	1,000 lbs concen max sq in
Capacity, air conditioner	40 Tons
Weight, computer	54,491 lbs
Weight, air conditioner	3,000 lbs

Air conditioner is located remote from computer. Site was prepared within an existing building. Modifications included raised flooring of wooden panel type, false ceiling approximately 8 2/3 feet from floor, wiring of various circuits to provide about 170 KVA, erection of walls of cinder block type. Various other minor modifications were accomplished to suit the area to effective computer operation.

AWS CC

Power, computer	119.0 KVA
Volume, computer	22,560 cu ft
Volume, air conditioner	4,000 cu ft
Area, computer	2,820 sq ft
Area, air conditioner	400 sq ft
Room size, computer	2,000 ft plus C.E. space and tape files
Room size, air conditioner	400 sq ft
Floor loading	80 lbs/sq ft
Capacity, air conditioner	60 Tons
Weight, computer	35,760 lbs

Building site is of stone and masonry construction with non-supporting interior walls. Modifications to the building consisted of construction of a raised floor of a raceway type, 8 inches high so that cables which connect the machines can be laid under the machine floor. A false ceiling of acoustic material was installed, reducing the room volume and providing a return air plenum for the air conditioning system. Also, a 600 amp. feeder line was installed from independent transformers (150 KVA) to a distribution panel in the computer room.

Social Security

Power, computer	1,500 KVA
Area, air conditioner	2,050 sq ft
Room size, computer	63 ft x 150 ft
Floor loading	150 lbs/sq ft 1,000 lbs concen max
Capacity, air conditioner	276 Tons

During construction of a reinforced concrete and brick building to house the agency, the following modifications were made to the area provided for the EDPM installation. Sectional floors with cable space beneath. Separate 1500 KVA power transformers and associated switching gear. Separate air conditioning system. Cold air is fed through ceiling ducts. The larger units of the system are provided with hoods to exhaust the heated air.

VA

Power, computer	155.14 KVA
Volume, computer	2,296,250 cu ft
Area, computer	13,578 sq ft

Basic warehouse remodeled to provide false ceilings, raised floors, provision for air conditioning, separate transformers, etc.

Commonwealth Edison

Power, computer	195.1 KVA 0.80 pf
Power, air conditioner	250 Kw
Volume, computer	30,000 cu ft
Volume, air conditioner	22,000 cu ft
Area, computer	3,000 sq ft
Area, air conditioner	1,950 sq ft
Room size, computer	5,000 sq ft
Room size, air conditioner	1,950 sq ft
Floor loading	75 lbs/sq ft 150 lbs concen max (Overgirder)
Capacity, air conditioner	250 Tons
Weight, computer	59,980 lbs
Weight, air conditioner	24,000 lbs

False ceiling, cable trenches in floor, floor is concrete over fill.

Eastman Kodak

Power, computer 150 Kw	170 KVA 0.88 pf
Volume, air conditioner	10,000 cu ft
Area, computer	2,938 sq ft
Area, air conditioner	800 sq ft
Room size, computer	4,800 sq ft
Room size, air conditioner	20 ft x 40 ft
Capacity, air conditioner	85 Tons

Figures are for two systems as listed under Price. Area developed was originally warehouse area on 2nd floor of two-story building. Exterior windows were removed and closed with masonry. Masonry walls were constructed to enclose a computer room, maintenance room, tape storage room, conditioner equipment room, clerical area and transceiver area. A suspended metal pan acoustic ceiling was installed throughout the areas. A raised 1 1/4 inch thick plywood floor was installed 12 inches above concrete building floor in computer room only to permit under floor cable runs to various machines. An asphalt tile floor was installed throughout areas. All ductwork for air distribution installed above suspended ceiling. All areas lighted with fluorescent fixtures.

IBM Methods

Power, computer 181.5 Kw	203.8 KVA 0.89 pf
Power, air conditioner	22 HP (fan motors)

Fan system uses central chilled water

Volume, computer	46,816 cu ft
Volume, air conditioner	1,600 cu ft
Area, computer	4,256 sq ft
Area, air conditioner	200 sq ft
Room size, computer	76 x 56 x 11 ft
Floor loading	300 lbs/sq ft 1,000 lbs concen max
Capacity, air conditioner	82 Tons

Existing concrete block building has 6 inch concrete slab floor; built-up roof on steel joists contains fan systems for air conditioning, chilled water for which is supplied from central distribution system, insulated main ducts feed over roof to branch ducts above suspended acoustical ceiling; "Doweloc" raised floor installed 1 ft 2 in over concrete slab; power supplied by outdoor 300 KVA transformer with 500 Amp feeder; loading dock installed to permit loading and unloading of machines.

International Harvester

Power, computer (entire system)	165.6 KVA 0.75 pf
Power, air conditioner	186 Kw 0.75 pf
Volume, computer	390.72 cu ft
Volume, air conditioner	16,800 cu ft
Area, computer	3,256 sq ft
Area, air conditioner	1,680 sq ft
Room size, computer	48 ft x 82 ft
Room size, air conditioner	20 ft x 42 ft (2 floors)
Floor loading	17 lbs/sq ft 250 lbs concen max
Capacity, air conditioner	120 Tons
Weight, computer	54,920 lbs

A new building was constructed specifically to house the computer and air conditioning equipment. Building is 1 story brick, with concrete floors and metal partitions. Cable ducts were constructed throughout the floor area of the machine room. Concrete floor is topped with wood and finished with plastic tile.

Westinghouse

Power, computer 120 Kw	150 KVA 0.8 pf
Volume, computer	35,000 cu ft
Volume, air conditioner	6,300 cu ft
Area, computer	3,900 sq ft
Area, air conditioner	420 sq ft
Capacity, air conditioner	80 Tons
Weight, computer	50,000 lbs

Metal false ceiling, reinforced concrete building, raised wood floor on concrete, walls metal studs lath and plaster, separate 150 KVA transformer and voltage regulator, and cold air ducts above ceiling - warm air return thru ceiling plenum.

PRODUCTION RECORD

Manufacturer

Only limited production at present. Delivery on availability basis only.

COST, PRICE AND RENTAL RATES

Manufacturer

		Monthly Charge	Purchase Price
714	Card Reader	$ 1,500	$64,450
717	Printer (150 lines/min)	1,400	55,000
720	Printer (500 lines/min)	1,900	93,000
722	Card Punch	800	43,000
727	Magnetic Tape Unit	550	18,200
730	Printer (1000 lines/min)	3,900	210,500
734	Magnetic Drum Storage	2,300	90,000
735	Printer Control (730 & 760)	600	32,500
744	Magnetic Drum Power Supply	500	21,500
754	Tape Control	1,500	78,000
757	Printer Control	650	44,000
758	Card Punch Control	600	36,000
759	Card Reader Control	900	45,000
760	Control and Storage	2,500	111,000
777	Tape Record Coordinator	3,400	156,000
705 III	CPU	15,000	788,000
739	Additional Core Storage	6,000	340,000
767	Data Synchronizer	3,500	200,000
748	D. S. Power Supply	700	53,000
782 II	Console Control	1,100	58,000
745 II	Power Supply	1,500	100,000

Monthly rental, typical system: $43,000 and up
Purchase price, typical system: $2,063,000 and up
Maintenance contract available.

USA SSA

Basic System	Qty	Monthly Rental
705 Model III CPU	1	$15,115
727 Magnetic Tape Units	12	6,600
734 Magnetic Drum Storage Unit	1	2,300
744 Magnetic Drum Power Unit	1	500
745 II Power Supply	1	1,500
754 Tape Control Unit	1	1,500
782 II Console and Typewriter	1	1,100
Total		$28,615
Additional Equipment		
714 Card Reader w/counter	1	$1,510
720A High Speed Printer	1	1,900
722 Card Punch w/counter	1	810
758 Card Punch Control Unit w/validity checking feature	1	650
759 Card Reader Control Unit	1	900
760 Control and Storage Unit	1	2,500
727 Magnetic Tape Unit	1	550
Total		$8,820

Maintenance included in rental.

USN SPCC

Prime shift rental amounts to $50,210 per month.

USAF W-P AFB

Central Processing Unit with console, 18 Type 727 Tape Units, 2 Type 777 Tape Record Coordinators, 1 Type 754 Tape Control Unit, 1 Type 744 Drum, 2 Type 717 Printers, 1 Type 714 Card Reader, 1 Type 722 Card Punch and associated power and control units; rental $45,300 monthly.

AWS CC

Rental contracting and rates for total system

Type	Name	Monthly Rental
705 III	Central Processing Unit	$15,000
745	Power Supply	1,500
782	Console Control Unit	1,100
714 (2)	Card Reader	3,020
759 (2)	Card Reader Control Unit	1,800
717	Printer	1,400
757	Printer Control	650
722	Card Punch	800
758	Card Punch Control	600
729/1 (4)	Magnetic Tape Unit	2,800
729/3 (4)	Magnetic Tape Unit	3,600
767	Data Synchronizer	3,500
748	Data Synchronizer Power Unit	700
	Total Monthly Rental	$36,470

Social Security

Rental Rates for Basic System

Rental rates shown are for prime shift. Additional time is charged at 40% of prime shift rental.

No.	Description	Monthly Rental
3	Central Processing Units (including power supply & console)	$52,350
28	729 Model III Tape Units	30,800
14	729 Model I Tape Units	9,800
8	Data Synchronizer and Power Supply	33,600
	Rental Rates for Additional Equipment	
4	720 Printers w/control unit	$15,600
6	Card Readers w/control unit	12,625
3	Card Punch w/control unit	1,400
15	729 Model I Tape Units	8,400

The magnetic tape to microfilm printer cost $250,000.

VA

One 705 III CPU, two 745 DSU, one 739 aux. core memory, six 729 I Tape Units, six 729 III Tape Units rent for $41,600 monthly.

Two 714 Card Readers, one 717 Printer, one 720A Printer rent for $12,650 monthly.

Commonwealth Edison

One IBM 705 Model III, one Type 734 Magnetic Drum, two Type 777 Tape Record Coordinators, 13 Type 727 Tape Units. Base rental for 176 hrs/month is $34,420.

Two Type 714 Card Readers, two Type 720-2 Printers, two Type 722 Card Punches, six Type 727 Tape Units. Base rental for 176 hrs/month is $19,860.

Maintenance is included in rental cost.

Eastman Kodak

One installation consists of:

	Qty	Cost Price	Monthly Rental
705 Model III High Speed	1	$1,010,000*	$17,300
745 Power Unit	1	100,000	1,500
782 Console	1	58,000	1,100
7211 Tape Control Unit	1	161,000*	3,110
729 III Tape Drives	10	300,000*	9,450
714 Card Reader	1	97,500	1,500
759 Card Reader Control Unit	1	54,000	900
722 Card Punch	1	44,400	800
758 Card Punch Control Unit	1	36,000	600
ANelex Print Station	1	150,000	-
727 Tape Drives	3	89,400	1,650
Total		$2,100,300	$37,910

*Estimated. Systems are rented.

IBM Methods

Type	Component	Qty	Total Price	Monthly Rental
705 III	Central Processor	1	$788,000	$15,000
714	Card Reader	1	64,450	1,500
759	Card Reader Control	1	45,000	900
717	Printer	1	55,000	1,400
757	Printer Control	1	44,000	650
729I	Magnetic Tape Unit	10	275,000	7,000
729III	Magnetic Tape Unit	7	339,500	6,300
745II	Power Supply	1	100,000	1,500
748	Data Synch. Power Supply	2	106,000	1,400
739I	Magnetic Core Stor-	1	340,000	6,000
754	Tape Control Unit	1	78,000	1,500
767	Data Synchronizer Unit	2	400,000	7,000
782II	Console Typewriter	1	58,000	1,100
			$2,692,950	$51,250

System is rented. Rental includes maintenance.

Additional equipment consists of:

714	Card Reader	1	$64,450	$1,500
759	Card Reader Control	1	45,000	900
720A	Printer	1	93,000	1,900
760	Control and Storage	1	111,000	2,500
722	Card Punch	2	86,600	1,600
758	Card Punch Control	2	72,000	1,200
727	Magnetic Tape Unit	4	72,800	2,200
			$544,850	$11,800

International Harvester

System consists of:

1 - 705 III & Power Supply
2 - 767 Data Synchronizers & Power Supplies
8 - 729 III Tape Drives
12 - 729 I Tape Drives
1 - 722 Card Punch & Ctrl. Unit
2 - 714 Card Readers & Ctrl. Units
2 - 720 Model 2 Printers & Ctrl. Units
Total prime shift rental is $56,600/month.
4 - Transceivers and Telephone Signal Units
Total prime shift rental is $700/month.

Westinghouse

CPU, console, 12 tapes, 1 magnetic drum rent for $29,600/month.

Reader, punch, 2 printers, 3 tapes rent for $10,000 per month.

PERSONNEL REQUIREMENTS

Manufacturer

Operator, programming, and technical training available as well as assistance at all levels.

USA SSA

	Programming One 8-Hour Shift		Operations Three 8-Hour Shifts	
	Used	Recomm	Used	Recomm
Supervisors	10	11	4	
Analysts	7	12		
Programmers	23	33		
Clerks	3	4		
Librarians			1	2
Operators			5	
In-Output Oper			3	
Scheduler			1	

Three supervisors and seven analysts expend part of their effort in analyzing and supervising the activities of the Electrical Accounting Machines Division.

Input-output operators double as tape handlers.

Operation tends toward open shop.

Methods of training used includes IBM Programming School for programmers, analysts, and operators, and formal and "on-the-job" training for programmers, analysts, and operators.

Programmers - 12 mos.
Operators - 6 mos.
Analysts - 12 mos. (6 mos., if a former programmer)

USN SPCC

Personnel requirements are as follows:

Operations Branch:
1 Branch Supervisor
3 Shift Supervisors
6 Digital Computer System Operators
1 Scheduler
1 Assistant Scheduler
5 Peripheral Equipment Operators
1 Clerk

Analysis Branch:
1 Branch Supervisor
3 Supervisory Analysts
7 Analysts

Program Branch:
1 Branch Supervisor
4 Supervisory Computer Programmers
20 Computer Programmers

2 Mathematicians (Trainees)

Operation Branch personnel work on a three shift rotating basis. Analysis and Program Branch personnel work only on the prime shift.

All EDPS personnel receive initial training in programming and additional on-the-job training for their regular assignments.

USAF W-P AFB

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	U	R	U	R	U	R
Supervisors	1	1	2	2	3	3
Analysts	1	1	1	1	1	1
Programmers	1	1	1	1	1	1
Clerks-Stock	1	1	2	1	2	2
Librarians	1	1	1	1	1	1
Operators	5	5	10	10	14	14

Includes 2 PCAM operators/shift.

Operation tends toward open shop.

Programming and operator training is provided by equipment manufacturer. Training in housekeeping functions such as tape handling, library operation, etc., are taught on-the-job.

AWS CC

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	7	7
Programmers	16	16
Clerks	1	1
Librarians	1	1
Operators	3	3
In-Output Oper	4	4
Tape Handlers	4	4

Operation tends toward closed shop.

Programmers:

Trainees for programmer positions are recruited from Civil Service registers of eligible mathematicians. They are subjected to a 120 hr. class (4 hrs. per day) of training covering the field of 705 programming. Additionally, the remaining 4 hrs. per day are spent in classroom study of subjects covered in the formal sessions. These classes are taught by IBM Technical Representatives and Programming Section Supervisors.

Operations Supervisors and Console Operators:

Personnel assigned as operations supervisors and console operators are subjected to the same training

as programmers. Additionally, console trainees are given on-the-job training by the console operator in the operation of the system.

Social Security

	Three 8-Hour Shifts
Supervisors	25
Analysts	18
Programmers	80
Clerks	15
Librarians	24
Operators	9
Engineers	18
In-Output Oper	63
Tape Handlers	40

Programming and operation are under separate supervision. Programming is in the Methods Branch which also prepare procedures for all operations, on and off of the machine and is responsible for over-all planning.

Programmers operate the machines during program testing and debugging. All other operating is done by the Report Processing Branch. Chiefs of both branches report to the Assistant Director in charge of the Accounting Operations Division.

Engineers are employees of IBM. Service is included in rental.

Operation tends toward closed shop.

Methods of training used includes a six-week programming course followed by on-the-job training.

VA

	One 8-Hour Shift Used	One 8-Hour Shift Recomm	Three 8-Hour Shifts Used	Three 8-Hour Shifts Recomm
Supervisors	4	4		
Analysts	8	10		
Programmers	5	9		
Clerks	2	2		
Librarians			6	6
Operators			6	6

Methods of training used includes IBM schools and on-the-job training.

Commonwealth Edison

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	6	7	8
Analysts	18	-	-
Programmers	8	-	-
Clerks	2	-	-
Operators	1	2	3
Engineers	2	3	4
Technicians	1	-	-
In-Output Oper	2	4	6
Tape Handlers	1	2	3

For the most part our staff has been acquired from within our own organization. However, we have hired a few analysts from the outside who have been math majors to meet increasing demands in the area of engineering applications.

Computer operating personnel rotate over the 3 shifts.

Operation tends toward open shop.

Methods of training used includes: methods analysts, programmers and computer operators attend the manufacturer's school for 4 weeks plus 3-4 weeks training under our own supervision.

Peripheral equipment operators and tape handlers are given on-the-job training under our own supervision.

Eastman Kodak

	One 8-Hour Shift
Supervisors	5
Analysts	2
Programmers	35
Clerks	13
Librarians	1
Operators	10
In-Output Oper	20

Above personnel figures are for following work schedules:

Supervision	1 shift
Analysts	1 shift
Programmers	1 shift
Clerks	1 shift
Librarian	1 shift
Operators	3 shifts on 1 computer system 2 shifts on 1 computer system
Input-Output Op	3 shifts

No recommendations are made as this depends on the amount of work being done currently and amount of work planned for the future.

Operation tends toward closed shop.

Methods of training used includes manufacturer's training courses, Kodak-developed course, and on-the-job training.

IBM Methods

	One 8-Hour Shift	Three 8-Hour Shift
Supervisors	1	3
Analysts	8	
Programmers	20	
Librarians		1
Operators		6

The data processing organization is composed of four groups:

- Methods Development
- Methods Programming
- Programming Standards
- Computer Operations

All operating people are sent to 705 Programming School for three week period and then trained on-the-job. Additional classes are held for the operators as new applications are installed.

International Harvester

	Two 8-Hour Shift	Three 8-Hour Shift
Supervisors	1	
Analysts	6	
Programmers	16	
Operators (Console)	1	1
Engineers	2	2
Technicians	1	
Tape Handlers	4	3

Some individuals do coding as write programs. Tape handlers and input-output operators are interchangeable or synonomous. Engineers and technicians are IBM employees.

Operation tends toward closed shop.

Tape handlers and console operators receive on-the-job training from the supervisor. Programmers receive basic training in programming at manufacturer's school for customers. Practicle training received from more senior programmers.

Westinghouse

	Two 8-Hour Shifts
Supervisors	5
Analysts, Programmers & Coders	20
Clerks	1
Librarians	1
Operators	2
Tape Handlers	4

Operation tends toward open shop.

Methods of training used are IBM schools plus on-site training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USA SSA

Good time 91 Hours/Week (Average)
Attempted to run time 101 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period from Apr 59 to Mar 60
Passed Customer Acceptance Test 16 Jul 56
Time is available for rent to qualified outside organizations.

Original system consisted of a 705 Model I, later changed to a Model II and III. Changeover was accomplished with no break in production.

Figures are for basic system only.

USN SPCC

The machine is operating on a three shift, five day week basis. All preventive maintenance is performed by the International Business Machines Corporation before the start of the prime shift and during weekends. Average main frame available productive time since installation of the Model III during June 1959 is 85%.

USAF W-P AFB

Good time 74.9 Hours/Week (Average)
Attempted to run time 90.3 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.83
Above figures based on period 1 Jan 60 to 30 Jun 60
Passed Customer Acceptance Test 10 Feb 59
Time is available for rent to qualified outside organizations.

Time is scheduled for agencies within Air Materiel Command when computer time available at those agencies is not sufficient to permit the completion of work to meet established deadlines. Donation of time has been made to another Air Force major command pending the installation of that command's own EDP system.

AWS CC

Average error-free running period 21 Hours
Good time 66 Hours/Week (Average)
Attempted to run time 75 Hours/Week (Average)
Operating ratio 0.88
Above figures based on period 4 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 14 Dec 59
Time is not available for rent to outside organizations.

Social Security

Time is not available for rent to outside organizations.

System may be made available to other government agencies, if time becomes available. Jobs for other government agencies may be handled on a reimbursable basis if time is available. The present machines have been installed recently to replace earlier models.

VA

Time is not available for rent to outside organizations.

Commonwealth Edison

Good time 93 Hours/Week (Average)
Attempted to run time 108 Hours/Week (Average)
Operating ratio 0.86
Above figures based on period 1 Apr 60 to 31 Jul 60
Passed Customer Acceptance Test Oct 59
Time is not available for rent to outside organizations.

Installed IBM 702 July 1955. Installed IBM 705 Model II April 1957 (replaced 702). Installed IBM 705 Model III October 1959 (replaced 705 II).

Eastman Kodak

Good time 171.2 Hours/Week (Average)
Attempted to run time 180.0 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period 1 Jan 60 to 10 Jun 60
Passed Customer Acceptance Test May 59
Time is available for rent to qualified outside organizations.

Per agreement with other 705 users, some computer time can be made available (mostly weekends) in cases of extreme emergency.

IBM Methods

105; 131; 0.80; Mar 60 to Jun 60; time available to qualified organizations

This computer is sometimes used as standby for customer use and customer test.

International Harvester

58; 64; 0.91; 1 Nov 59 to 30 May 60; 1 Sep 59; time not available

Running time does not include set up time. "Attempted to run " time is only machine failure; it does not include reruns necessitated by erroneous input data.

Westinghouse

Average error-free running period 2 Hours
Good time 72 Hours/Week (Average)
Attempted to run time 82 Hours/Week (Average)
Operating ratio 0.88
Above figures based on period from Jan 60 to Sep 60
Passed Customer Acceptance Test Jul 56
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Special Representatives

This group offers overall consulting service in connection with the study of possible uses.

Educational Program

One-week classes conducted for executives at IBM educational departments in Endicott and Poughkeepsie, New York. Comparable classes are available in several major cities across the country. These courses are designed to acquaint executives with the organization, operating characteristics, capacities, and applications of the 705. Customers who complete this course are better able to evaluate the advantages, economics and wide business applications of the 705. In addition to the executive class, courses are available to qualified methods personnel. These courses are of longer duration and provide knowledge of programming and necessary operating details.

Programming Service

Personnel are available for consultation with field representatives and customers. A library of programs common to many problems is available for adoption as sub-routines by customer. Automatic coding as listed under Programming and Numerical System (automatic coding) are available. Symbolic coding methods and assembly programs are available.

Sales Engineering

Engineers are available to assist in preparing the site for physical installation. This assistance begins twelve months in advance of delivery.

USA SSA

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include especially constructed shipping containers for impact protection during cross country shipments of magnetic tape.

USAF W-P AFB

Outstanding feature is microsecond interrogation.

A cinder block vault in an air conditioned area, certified for storage of classified material serves to provide excellent physical protection. Tape Library System demands labeling and storage methods consistent with good housekeeping practices.

Air Materiel Command Automatic Data Processing System

Type Systems

Organization	305	650B	650T	650TR	705II	UFC	Un I	1105	205	220
Hq AMC					1					
WPAFB	1	1								
MAAMA		1	2		1					
MOAMA		1	1		2					
OCAMA	*1	1	3		2					
OOAMA		1		1	1					
ROAMA		2				1		1		
SAAMA		3			2					
SBAMA		1			2				1	1
SMAMA		4				1		1		
WRAMA		3				1		1		
DAFD		2					1	1		

The 2709th AF Veh Cont Grp, Memphis, Tenn., has 1 IBM 650B and one IBM 705 II, the NATO Materiel Supply Services Agency, Chateauroux, France has 1 IBM 650B, and the Air Materiel Force, Pacific Area, Tachikawa AFB, Japan, has 1 IBM 650B.

* 705 II - 305 coupled configuration

AWS CC

Magnetic tapes are labeled with an identification label written magnetically as the first record on tape and a "Label-on" type plastic sticker on the reels identifying the information which the reel contains. Tapes are stored in metal cabinets under the same dust-free and humidity controlled, air conditioned conditions as are maintained in the computer room. The air conditioning system is controlled to maintain temperature and relative humidity within limits specified by IBM. A round the clock surveillance with ample fire extinguishing equipment is being maintained. An investigation is currently under way to determine the adequacy of the present fire protection facilities.

Social Security

All active tapes contain magnetic header labels. Tape reels are labeled with pressure-sensitive tape. Tapes are stored in cabinets in separate air conditioned library room, separated from machine rooms by brick fire-wall. Each reel is in a plastic container. For storage outside of air-conditioned area, tapes are sealed in moisture-proof bags. Tapes which may be needed for reconstruction of our records following a disaster are stored in an out of town records center.

Commonwealth Edison

Outstanding features are consolidation of data into magnetic tape files, accuracy and uniformity of computer processing, reduction in personnel and related dollar savings, up to date information provided on customers accounts to customer contact people, consistency of handling data and rejection of incorrect information, and reduction in time over previous system in rendering customer bills.

1st record on tape provides identification, external labels are used for visual identifications and expiration date. Tape stored in fireproof vault. Temperature and humidity controlled at all times, within specified limits. Pyr-a-larm protection system installed to detect smoke. Will soon provide alternate storage area for previous cycle of tapes to minimize effect of catastrophe in computer area.

Eastman Kodak

Temperature and humidity under rigid control. Entire area protected by sprinkler system. We have a separate tape retention vault at a different location for storage of back-up tapes for protection in the event of emergency.

IBM Methods

A unique system advantage is a 705 III with ability to operate as 705 I, 705-2 or 705-3 with 754 Tape Control or data synchronizers.

A daily security storage program for protection of tapes is in effect. Tape labels written and tape reels physically labeled.

International Harvester

Adopted procedures for:

Magnetic Tape Labeling: Each reel of input contains an 80-column label as the first record. This label identifies the file - but does not include any statistics regarding number of times the reel has been processed or destruction date. Labels are written on tapes saved for future processing, but not on those prepared for immediate auxiliary printing or punching. No attempt is made to determine whether scratch tapes do not have label from prior processing.

Storage: Tapes not actually in use for processing at any given time are stored in a fireproof vault adjoining the machine room. Regular tape storage racks hold reels which are arranged by applications.

Shipping: No requirements for shipping tapes between locations.

Protection from Humidity: - Temperature and Other Damage: The vault previously mentioned is a part of the area served by the air conditioning system. Rigid temperature and humidity controls are maintained, and when the allowable limits are exceeded, a warning buzzer with signal light so notifies the occupants of the machine room. The air conditioning is composed of 3 compressors, 1 of which is strictly for standby purposes so that 2 can always be in operation when the computer is operating. When the computer is not operating, a single compressor is adequate for maintaining proper temperature and humidity throughout the building.

As an added precaution against fire, heat detectors are located throughout the ceiling of the machine room. These are set to bring in an alarm at 225°F. Fire extinguishers are mounted on the wall throughout the building for added protection. The building construction is as fireproof as possible.

Westinghouse

80 character magnetic tape label.

Tapes stored in metal cases in 705 machine room.

Humidity controlled between 40% and 50% relative.

FUTURE PLANS

Manufacturer

There is a growth upwards from the 705 with complete program compatibility to the 7080 Data Processing System.

USA SSA

High speed tapes for input, output.

An IBM 1401 System is on order to replace all peripheral equipment listed.

USN SPCC

Two IBM 1401 Data Processing Systems are currently on order. A Model C-3 and a Model D-3 are scheduled for delivery. This equipment will replace the Types 717 and 720 Printers, the card punch and the card reader. Installation of the Type 1401 Systems will

provide a maximum printing capacity of 1200 lines per minute in lieu of the current capacity of 650 lines per minute, and will also provide additional processing time for certain applications such as; sorting, editing, etc.

AWS CC

A study is under way to determine the feasibility of replacing some of the components of auxiliary equipment (i.e. printer, card punch or card reader) with a 1401 Data Processing System. This system would be used to perform the auxiliary card to tape, tape to card, tape to print and tape to tape operations.

Social Security

Replacement of all input-output units by six 1401 Systems.

Replacement of 705's by 7080's.

Planning the following new applications:

Personnel Statistics
Payroll
Property and Supply inventories
Budget
General Ledger Accounting

VA

An IBM 1401 is planned for installation.

USDA CSS

This agency has on order 2 1401-C3 Central Processing Units, 2 1402 Card Read Punch Units, 3 1401-D3 Central Processing Units, 3 1403-2 Printers, 5 729 Model II Tape Units. This equipment will replace our present off-line configurations.

Commonwealth Edison

Equipment on Order

Additional 40,000 positions of memory for present 705 III (this will eliminate the magnetic drum).

3 IBM 1401 Tape Systems (to replace present card readers, punches and printers).

1 IBM 7080 Computer - to replace the 705 III.

1 Farrington Optical Scanner - to be used in conjunction with our customer accounting system wherein the cash stub portion of our bill which is returned by the customer at the time of payment will be processed through the scanner to read the printed account number and dollar amount and convert this information directly to magnetic tape.

Future Plans for Computer Application

General Accounting
Payroll
Stockholder Records
Additional Engineering Applications

In Process

We are presently converting our manual billing system for large industrial customers to an IBM 305 RAMAC. This conversion will be completed by the end of 1960. The 305 is housed in the same room as the 705. The 305, being a random access type computer, will be able to provide current account information upon request through the inquiry feature provided. Again, the uniformity and accuracy of computer processing will be a decided improvement over the present manual system.

Eastman Kodak

Our work in the future will consist of extension of work already being done, particularly in the areas of inventory control and production planning and scheduling.

As to acquisition of new systems, we have on order two IBM 1401 Tape Systems and two IBM 7080 Computer Systems.

IBM Methods

The 705 III System (now installed) will be replaced with a 7080 System, increasing the overall speed by a factor of about 5.5. This system will be supported by two 1401 Systems for off line operations and computing problems requiring less speed and storage.

International Harvester

It is anticipated that present card reading, card punching, and printing components will be replaced by 1401 Tape Systems - 1400 series equipment to be received:

2 card readers and punch units
2 printers
2 1401 Computers (4,000 positions of storage)
5 tape drives

Investigation is presently underway to determine the possibility of replacing present 705 with a 7080. This appears to be the logical conversion to provide for constantly increasing volume and additional applications.

Beginning the first of August, an order status tape has been established. This contains all open orders for trucks in detail by component units required to build those trucks. Each day, this tape will be increased by order received and relieved of trucks built. The built trucks will be exploded down to the part number level to provide the disbursement factor for a complete daily stock status updating. These stock status records will become the perpetual book inventory. Stock status will, of course, include daily receipts, and mortgaged material for the next 5 days production will be developed.

We expect to install a more comprehensive sales analysis program than is currently being used.

Westinghouse

Plan 60 KC Tapes.

Plan 1401-C to replace present peripheral equipment.

Plan complete integration of manufacturing operating systems.

INSTALLATIONS

U. S. Army Signal Supply Agency
225 S. 18th Street
Philadelphia, Pennsylvania

U. S. Naval Ships Parts Control Center
Mechanicsburg, Pennsylvania

Wright-Patterson Air Force Base
Statistical Services Division
Ohio

Air Weather Service Climatic Center
225 D Street, S.E.
Washington 25, D. C.

Social Security Administration
Department of Health, Education & Welfare
Social Security Building
Woodlawn
Baltimore 35, Maryland

Veterans Administration
Data Processing Center
Hines, Illinois

Commodity Stabilization Service
U. S. Department of Agriculture
New Orleans, Louisiana

Commonwealth Edison Company
72 W. Adams Street
Chicago, Illinois

Eastman Kodak Company
Rochester, New York

IBM Methods - DS Manufacturing
South Road
Poughkeepsie, New York

International Harvester Company
Motor Truck Division
Box 1109 Meyer Road
Fort Wayne, Indiana

Westinghouse Electric Corporation
Sharpsville Avenue
Sharon, Pennsylvania

Western Electric Company
100 Central Avenue
Kearny, New Jersey

Western Electric Company
Hawthorne Station
Chicago 23, Illinois (Proposed)

Standard Oil Company of Ohio
717 Republic Building
Cleveland 15, Ohio

Boeing Airplane Company
Plant II
Wichita, Kansas (Proposed)

Consolidated Edison Company of New York
4 Irving Place
New York 3, N. Y.

IBM 709

IBM 709 Data Processing System

MANUFACTURER

International Business Machines Corporation

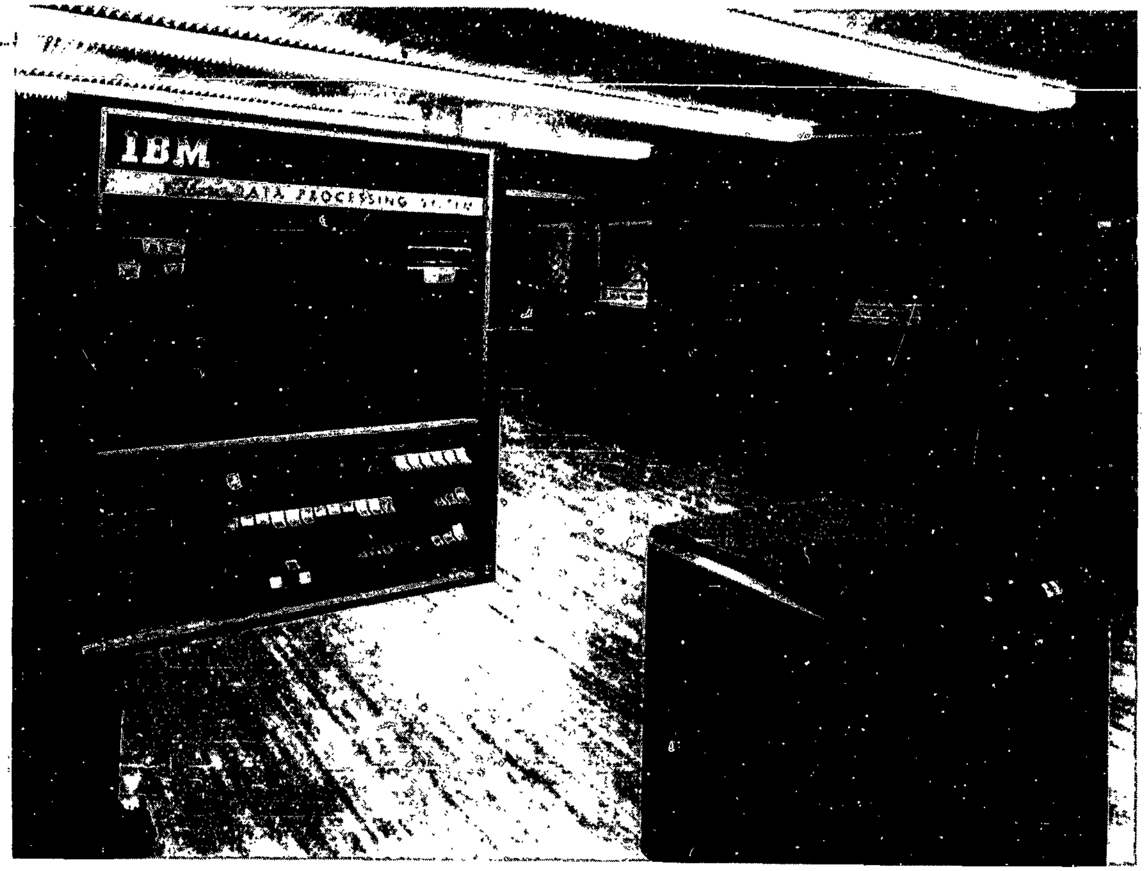


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

This is a general purpose computer doing both scientific computing and commercial work. The system is scientifically oriented with fast internal speeds.

USA Ballistic Missile Agency Redstone Arsenal

Located at Computation Laboratory, Redstone Arsenal, Alabama, the system is used for scientific and commercial applications.

U. S. Army Electronic Proving Ground

Located in Greely Hall, Fort Huachuca, Arizona, system is used in support of the tactical field army and the technical program of the departments of the U. S. Army Electronic Proving Ground.

U.S.N. Pacific Missile Range Pt. Mugu

Operated by Land Air, Inc.

Located at the Pacific Missile Range, Point Mugu, the system is used for the processing of missile test data (radar, optical, and telemetry), for real time applications, and for the solution of general mathematical problems.

Land Air, Inc. operates two 709's for the Navy, one at Point Mugu, California and one at Point Arguello, California. Land Air is the lessee, and our major committment is for missile test flight data reduction. In addition, we provide computing facilities for the entire installation at Mugu (general scientific and engineering research and data processing).

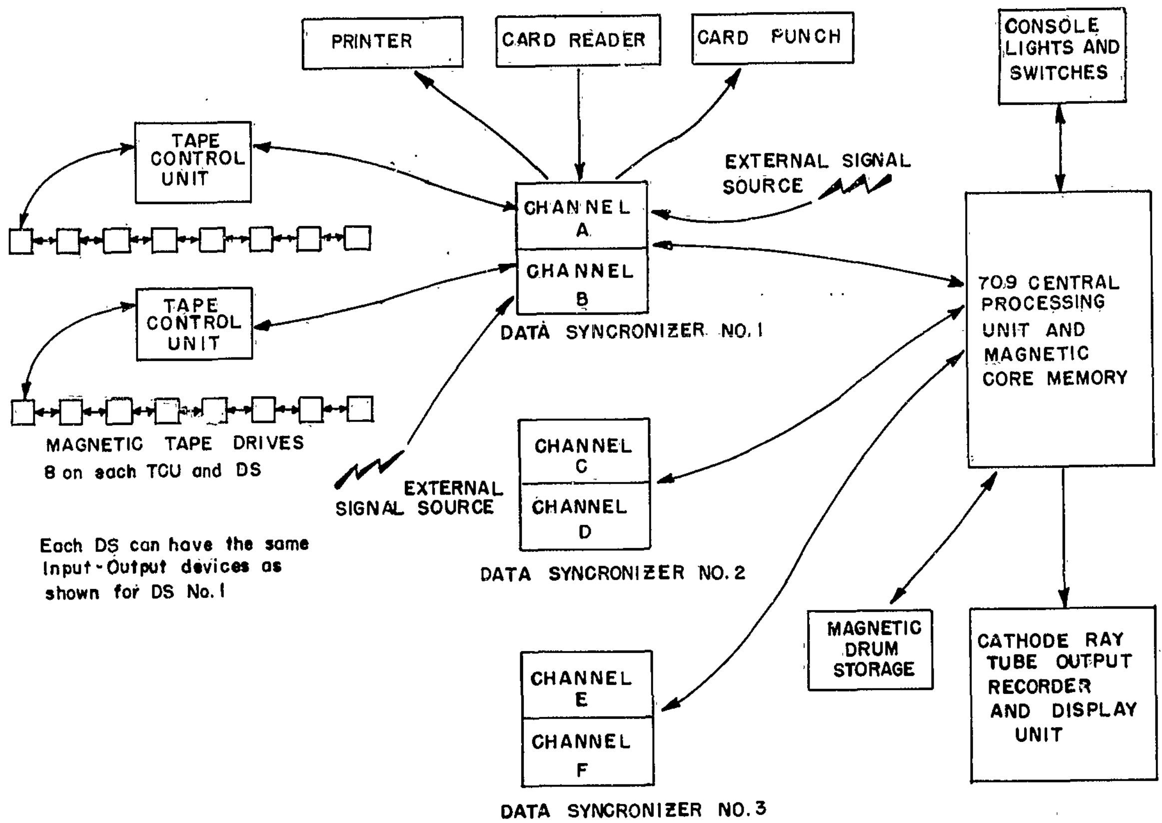
U.S.N. Pacific Missile Range Pt. Mugu

Operated by Land Air, Inc.

Located at the Naval Missile Faculty, Point Arguello, California, the system is used on the main problem of range safety impact predicition in real time using FPS-16 Radar and Cubic COTAR data. System is also used for post flight trajectory reduction of FPS-16 radar data and for trajectory integration and analysis, etc.

USN OTS China Lake, California

Located at the Data Computation Branch, Assessment Division, Test Department, the computer is used for data reduction and scientific computation as related to Naval Ordnance, Test, Development & Research (15% of computer time devoted to management data processing).



SCHEMATIC SHOWING DATA FLOW FOR INPUT-OUTPUT FOR IBM 709 DATA PROCESSING SYSTEM

Chart by International Business Machines Corporation

National Aviation Facilities Experimental Station (FAA)
Located at Atlantic City, New Jersey, the system is used for fast time simulation of air traffic control systems, data reduction on data collected in various areas of air traffic control, data analysis, real time simulation, statistical analysis, and probability problems.

C E I R, Inc.
Located at 1200 Jefferson Davis Highway, Arlington 2, Virginia, the system is used for linear programming, multiple regression, business data processing, and flight simulation, plus applications of our clients who rent time from us.

Douglas Aircraft Company (2)
Located at A-250, and A-260, Santa Monica, both systems are used for strength analysis, trajectories, aerodynamic stability, aerodynamic performance, dynamic response, weight control, and propulsion analysis.

Ford Motor Company
Located at the Central Services Building, Ford Road, Newport Beach, California, the system is used for computation of missile trajectories within the earth's atmosphere, computation of orbits (in light atmosphere or free space), computation of rocket motor performance, hydrodynamic computations, missile component design computations, computer system simulation, miscellaneous scientific and engineering computations, data reduction of experimental and flight test data, and payroll, inventory control, and miscellaneous business applications.

Hughes Aircraft Company
Located at Florence Avenue & Teale Streets, Building 6, Room F1022, Culver City, California, the system is used for all forms of numerical computation, including differential equations, numerical integration, parameter studies, solution of simultaneous equations, matrix manipulations, polynomial equations, integral equations, simulations of various systems (computers, mass raid attacks, fire control systems) partial differential equations, harmonic analysis, auto correlation and power spectrum analysis, statistical computations, Monte Carlo evaluations of various problems, network analysis, research in computer systems (assemblers, compilers), design studies, and development of problem oriented languages.

IBM Space Computing Center
Located at 615 Pennsylvania Avenue, N.W., Washington, D. C., the system is used for orbital calculations for space vehicles, including formulation, testing and production, test center applications for Federal Systems Division of IBM, and customer test center for local 709 users who have ordered machines.

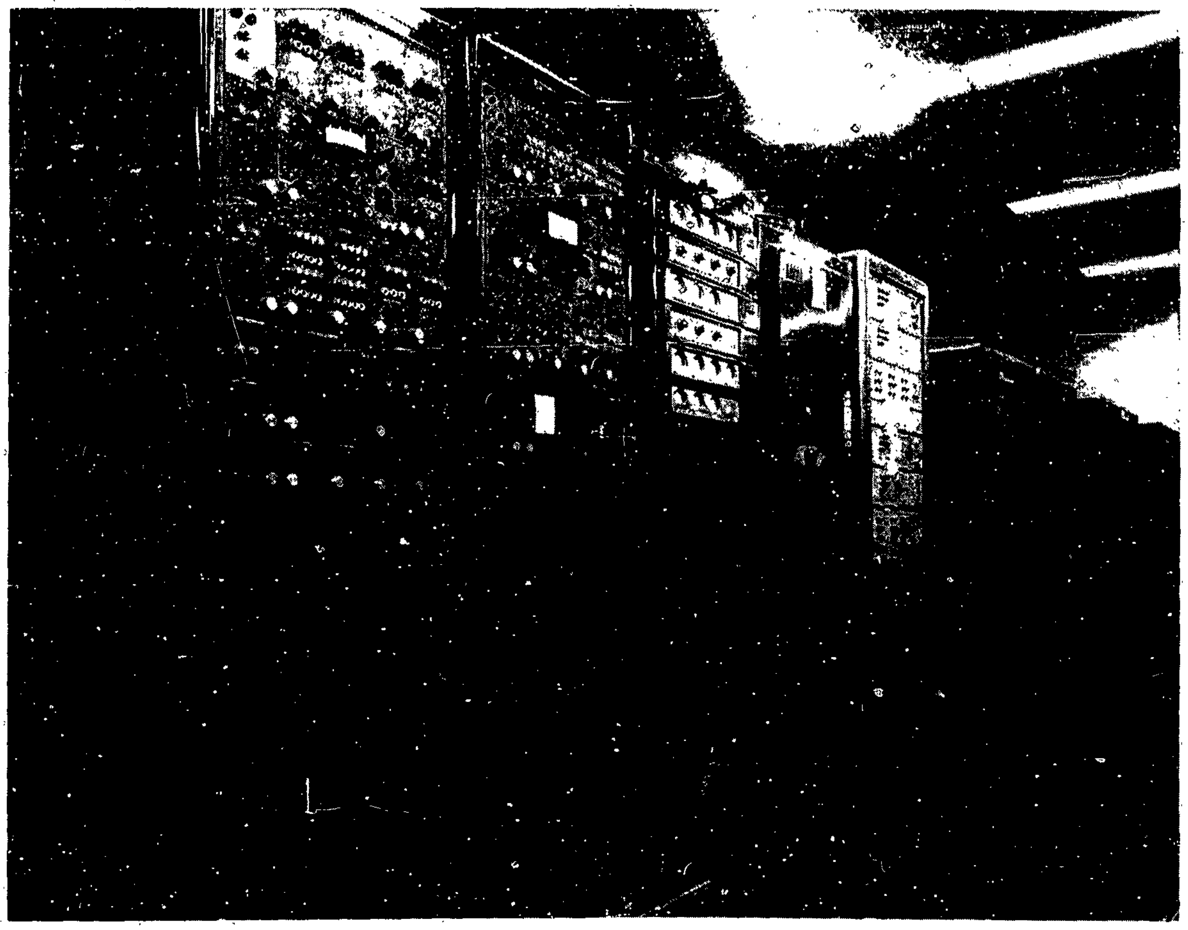


Photo by International Business Machines Corporation

Lockheed Aircraft Corporation-Burbank
Located at Burbank, California, the system is used to solve all scientific and engineering problems submitted by the Engineering Division.

Lockheed Sunnyvale
The computing installation consists of two IBM 709's and peripheral equipment. It is used for scientific calculations involving matrix inversion, partial differential equations, trajectories, solutions for simultaneous equations, etc. The systems are also used for flight data reduction involving the preparation of labels and plotting tapes, data reduction and computation of calibration. Admisistrative applications include the solution of financial, material, and statistical problems.

The Martin Company-Baltimore
Located at the Missile Weapons Systems Division, Baltimore, Md., the system is used for missile design, vibrations analysis, nuclear shielding, reactor design, electronic design, information retrieval, trajectory analysis, compilers, aerodynamic research, circuit analysis, master lines automation, numerically controlled tools, data reduction, weight calculation automation, statistical analysis, structural analysis, and molecular research.

The Martin Company-Orlando
Located at the Engineering Division, the system is utilized for scientific calculations in engineering design, parts and assembly control, production and updating of engineering parts lists, and special reports emanating from complete files of system parts and components.

McDonnell Aircraft Corporation
Located on the 1st level of Bldg. 33, Engineering Campus, the system is used for flutter analysis, trajectory studies, probability studies, stress and loads analysis, aerodynamic performance, thermodynamic problems, numerical control of milling machines, flight test and wind tunnel data reduction, operations analysis, and engine performance.

Northern States Power Company
Located at 1925 Sather Street, St. Paul 13, Minnesota, the system is used for customers' billing and accounting, load flow studies, generator outage probabilities, plant life actuarial analyses, substation and feeder load record, and transformer loading and forecasting.

Phillips Petroleum Company
Located in the Adams Building at Bartlesville, Oklahoma, the system is used for the solution of engineering, technical and research problems and business accounting.

RCA Missile & Surface Radar Division
Located in Bldg. 116-1 Moorestown, N. J., the system is used for the real-time control of BMEWS (Ballistic

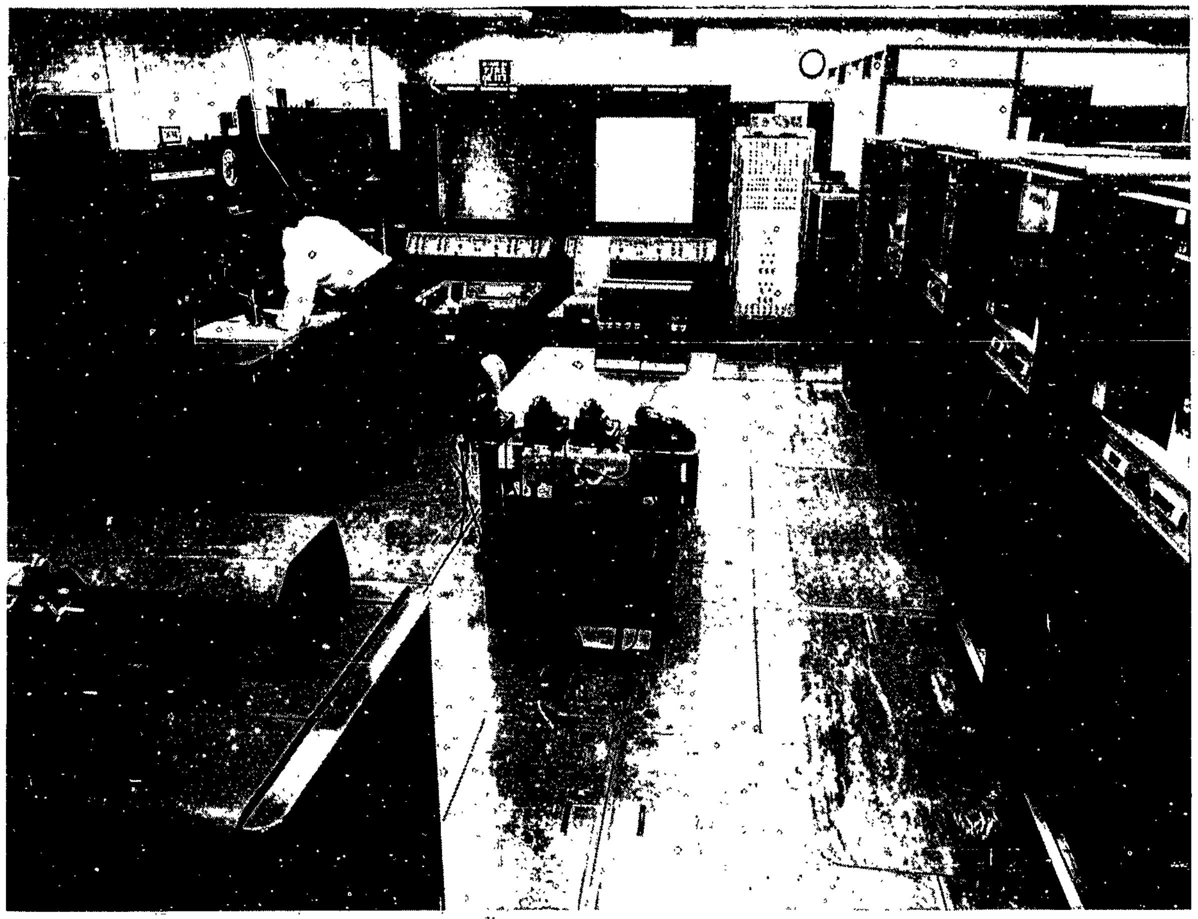


Photo by USAF AMR Cape Canaveral

Missile Early Warning System), for engineering model tracking radar, for engineering calculations associated with design of BMEWS sites, and for data reduction for the Down Range Anti-Ballistic Missile Program (DAMP).

RCA Service Company, Patrick AFB
Located in the Technical Laboratory, Bldg. 989, Patrick Air Force Base, Florida, the system is used primarily to determine missile trajectory information (time, position, velocity, and acceleration) from observed observations, azimuth, elevation and slant range (where available). Data sources are Azusa, FPS-16, Mod II radar, ballistic camera, fixed camera, cine-theodolite, and DOVAP. Also digitizing and linearization of telemetry is performed.

RCA Service Company, Cape Canaveral
Located at Bldg. 2-1655, Cape Canaveral, Florida, the system is used for real time impact prediction computing during ballistic missile launches, ground instrumentation check outs, near real time computation for acquisition and vehicle recovery operations, post flight data reduction, and other engineering and scientific problems.

Space Technology Laboratories, Inc. (2)
Located at El Segundo, California, both systems are used in a full spectrum of scientific computations.

System Development Corporation
Located at 1923 Centinella Avenue, West Los Angeles, California, the system is used for data processing applications for the development of a system training program.

M. I. T. Lincoln Laboratory
Located at the M. I. T. Lincoln Laboratory, Lexington, Massachusetts, the computer is used for real time systems studies; evaluation, simulation, and analysis, physical data processing, and programming research.

University of California LRL
Located at Livermore, California, the system is used for the solution of differential equations.

University of California, Los Angeles
Located at the University of California, Los Angeles campus, the system is used for research and education in all university disciplines, with special emphasis on business management problems, operations research, gaming, and computer systems development.

Photo by USN PMR Point Mugu

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36
Binary digits/instruction	36
Instructions/word	1
Instructions decoded	187
Arithmetic system	Fixed and floating point
Instruction type	One address
Number range Floating	$-10^{38} < N < 10^{38}$
Fixed	$-(2^{35}-1) \leq N \leq (2^{35}-1)$

Instruction word format

Oper Code	Flag	Tag	Address
S,1 11	12-13	18-20	21 35

Format varies with instruction type.

SHARE Operating System (SOS) and FORTRAN are used. There are 4 arithmetic registers (full word), viz. accumulator, multiplier-quotient, storage, and sense. There are 3 index registers.

ARITHMETIC UNIT

	Incl Stor Access Micorsec Fixed Pt.	Floating Pt.
Add	24	84
Mult	24-240	24-204
Div	36-240	36-216

Construction (Arithmetic unit only)

Vacuum tubes	2,000
Diodes	14,500
Arithmetic mode	Parallel
Timing	Synchronous for Central Processing Unit Asynchronous for Input-Output
Operation	Sequential for Central Processing Unit Concurrent Input-Output devices

Input-Output operations on up to 6 data channels can operate concurrently with the main program in the CPU (Central Processing Unit).

Photo by USAF AFMTC Patrick AFB

STORAGE

Manufacturer

Media	No. of Words	No. of Bin/Word	Access Microsec
Core	4,096; 8,192 or 32,768	36	12
Magnetic Drum	8,192 or 16,384	36	35,000 for initial word, 96 for subsequent wds.
Magnetic Tape	Up to 48 reels at approx. 1/2 million words/reel 10.8 millisec access		

No. of units that can be connected	48 Units
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Char/sec
Start-stop time	10.8 Millisec
Average time for experienced operator to change reel of tape	30-60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Acetate or Mylar

Mylar is DuPont's registered trademark for polyester film.

USA BMA Redstone
32,768 words Magnetic Core; Magnetic Tapes
USA EPG Fort Huachuca
32,768 words Magnetic Core; 24 Magnetic Tape Stations
USN PMR Pt Mugu
32,768 words Magnetic Core; 24 Magnetic Tape Stations
USN PMR Pt Mugu
8,192 words Magnetic Core; 6 Magnetic Tape Stations
USN OTS China Lake, Calif.
32,768 words Magnetic Core; Magnetic Tape
NAFE FAA
32,768 words MC; Mag Tape
CEIR
32,768 MC; Mag Tapes
Douglas
32,768 MC; 13 Mag Tape Sta.
Douglas
32,768 MC; 10 MT
Ford
32,768 MC; 9 MT
Hughes
32,768 MC; MT
IBM Space
32,768 MC; 14 MT Type 729-I
Lockheed Burbank
32,768 MC; MT

Photo by IBM Space Computing Center Washington

Lockheed Sunnyvale
32,768 MC, ea; 12 MT Type 729-I, ea.
Martin Baltimore
32,768 MC; 10 MT Type 729-I
Martin Orlando
32,768 MC; MT
McDonnell
32,768 MC; MT
Northern States
8,192 MC; MT
Phillips
8,192 MC; MT
RCA Moorestown
32,768 MC; MT. The 8,000 word magnetic drum was removed 6 months after initial installation of computer.
RCA Patrick AFB
8,192 MC; MT
RCA Canaveral
8,192 MC; MT
Space Tech Labs
32,768 MC; MT
Space Tech Labs
32,768 MC; MT
System Development Corp
32,768 MC; MT
MIT
32,768 MC; 10 MT Sta
UCLRL
32,768 MC; 10 MT Sta
UCLA
32,768 MC; 8,192 Drum; MT

INPUT OUTPUT

Manufacturer

Media	Speed	
Magnetic Tape	(Reads-records in BCD or Binary)	
Cards (Read)	250 cards/min	(on-line)
Card-to-Tape	250 or 800 cards/min	(off-line)
Card (Punch)	100 cards/min	(on-line)
Printed Page	150 lines/min	(on-line)
Cathode Ray Tube	135 microsec/point	(on-line)
Tape-to-Card	100 or 250 cards/min	(off-line)
Tape-to-Printer	150 or 600 lines/min	(off-line)

The 800 cards/min is obtained when the IBM 1401 System is used for generating input tapes.
The higher rates are obtained when using the IBM 1401 off-line for Tape-to-Card and Tape-to-Printer.

USA BMA Redstone
Tapes, Cards, Printer
USA EPG Fort Huachuca
Tapes, Cards, Printer
USN PMR Pt Mugu
Tapes, Cards, Radar Data, Printer
USN PMR Pt Mugu
Tapes, Cards, Printer, Radar Data, 30 x 30 Plotting Boards.
USN OTS China Lake
Tape, Cards (on and off-line), Printer (on and off-line), Direct Data Device at 27,777 words/sec. Input from analog to digital conversion facility with real time capability.
NAFE FAA
Cards, Tape, Direct Data Entry 27,777 words/sec.
CEIR
Cards, Tapes (729I, II and IV), Printer
Douglas (2)
Tapes, Cards, Printer

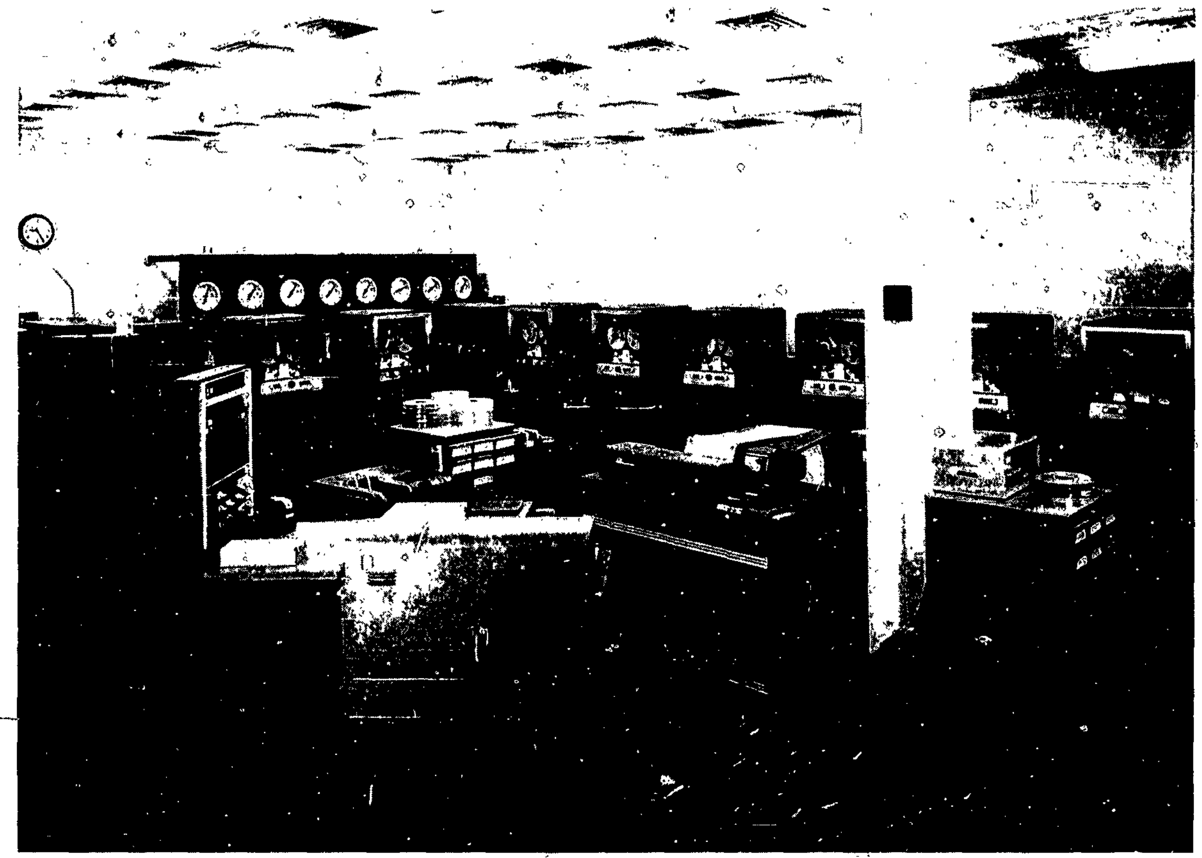


Photo by Hughes Aircraft Company

Douglas
Tapes, Printer
Ford
Tapes, Cards, Printer
Hughes
Tapes, Cards, Printer
IBM Space
Tapes, Cards, Printer (on and off-line)
Lockheed Burbank
Tapes, Cards, Printer
All input of programs to the machine is on magnetic tapes. Card Reader is used only to initialize particular input tape.
All output of printed or punched information is placed on magnetic tapes. The printer is used to monitir the system.
Lockheed Sunnyvale
Tapes, Cards, Printer, Paper Tape
Paper Tape input/output is available on only one 709 system.
Martin Baltimore
Tapes, Cards (on and off-line), Printer (on and off-line), Cathode Ray Tube 7100 dots/sec
Martin Orlando
Tape, Cards, Printer
McDonnell
Tape, Cards, Printer (on and off-line)
Northern States
Tape, Cards, Printer
Phillips
Cards, Tape, Printer (on and off-line)
RCA Moorestown
Tape, Cards, Printer (on-line)
Printer is used for operator remarks only.
RCA Patrick AFB
Tape, Cards, Printer (on and off-line). Paper Tape is transcribed to magnetic tape with off-line converter.
RCA Canaveral
Tape, Cards, Printer (on and off-line), Computer output direct to teletype at 60 or 100 words/min, real time direct data input at 30, 50, and 80 words/sec.
Space Tech Labs
Tape, Cards, Printer
Space Tech Labs
Tape, Cards, Printer
System Development Corp
Tape, Cards on line. All unit reocrd operations - card-to-tape, tape-to-card, and tape-to-print are performed off-line.

Photo by Lockheed Aircraft Corporation, Sunnyvale

MIT

Media	Speed	
Magnetic Tape	15,000 char/sec	
Cards (Reader)	250 cards/min	
Paper Tape	240 lines/sec	(Via Direct Data Entry)
Magnetic Tape	320 words/sec	(Via Direct Data Entry)
Cards (Punch)	100 cards/min	
Printer	150 lines/min	
Cathode Ray Tube	7,100 points/sec	

Various other inputs (e.g. phone line) are used with the Direct Data Entry feature from time to time.

UCLRL

Cards, Tape, Printer

UCLA

Cards, Tape, Printer (on-line), Cathode Ray Tube at 7,000 points/sec. utilize 714 card-to-tape for input preparation and 720 II Printer and 717 Printer off-line for output.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

There are 295,000, or 590,000, or 1,180,000 magnetic cores, depending on size of memory.

CHECKING FEATURES

Manufacturer

Accumulator overflow; divide check; floating point overflow and underflow; data channel I/O check; horizontal and vertical points check on magnetic tape; dual level sensing; two gap head for verification of tape writing; echo checking on line printer.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer		125.2 KVA
Weight, computer		2,110 lbs

Physical Planning Manual available on request IBM Form No. 12-7967-1.

USA BMA Redstone

Power, computer	94.8 Kw	131.8 KVA	0.72 pf
Volume, computer		26,800 cu ft	
Area, computer		1,376 sq ft	
Room size, computer		1,800 sq ft	
Floor loading		25.0 lbs/sq ft	
		1,000 lbs concen max	
Capacity		26.5 Tons	
		318,750 BTU/hr	
Weight, computer		34,370 lbs	

Photo by Lockheed Aircraft Corporation, Sunnyvale

USA EPG Fort Huachuca

Power, computer		236.6 KVA	
Capacity, air conditioner		150 Tons	
		520,420 BTU	

USN PMR Pt Mugu

Power, computer	138.5 Kw	205.6 KVA	0.67 pf
Power, air conditioner		300 KVA	
Volume, computer		2,432.6 cu ft	
Volume, air conditioner		15,000 cu ft	
Area, computer		454.5 sq ft	
Area, air conditioner		960 sq ft	
Floor loading		11.8 lbs/sq ft	
		2.50 lbs concen max	
Capacity, air conditioner		70 Tons	

USN PMR Pt Mugu

Power, computer	112.5 Kw	157.7 KVA	0.71 pf
Volume, computer		1,415 cu ft	
Area, computer		264.6 sq ft	
Floor loading		250 lbs concen max	
Capacity, air conditioner		43 Tons	
Weight, computer		42,060 lbs	

False ceiling, plenum floor, and concrete addition to building.

USN OTS China Lake

Power, computer	70 Kw	100 KVA	0.70 pf
Power, air cond	87 Kw	100 KVA	0.87 pf
Volume, computer		2,244 cu ft	
Volume, air conditioner		7,000 cu ft	
Area, computer		420 sq ft	
Area, air conditioner		800 sq ft	
Room size, computer		1,776 sq ft	
Room size, air conditioner		850 sq ft	
Floor loading		175 lbs/sq ft	
		250 lbs concen max	
Capacity, air conditioner		80 Tons	
Weight, computer		52,110 lbs, incl peripheral equipment	
Weight, air conditioner		15,000 lbs	

Computer is located in a fire-proof area. The computer area is not adjacent to any inflammable or explosive material or gases, stored, manufactured, or processed.

Structural conditions: All concrete-floor, walls and roof.

Partition separations from other areas (office) are fabricated steel 3" thick with fire-proof insulation.

Floor: All steel removable panel construction, elevated one (1) foot above supporting concrete deck.

Ceiling: Steel acoustical tile panels with 1" fiberglass insulation attached to underside of concrete roof.

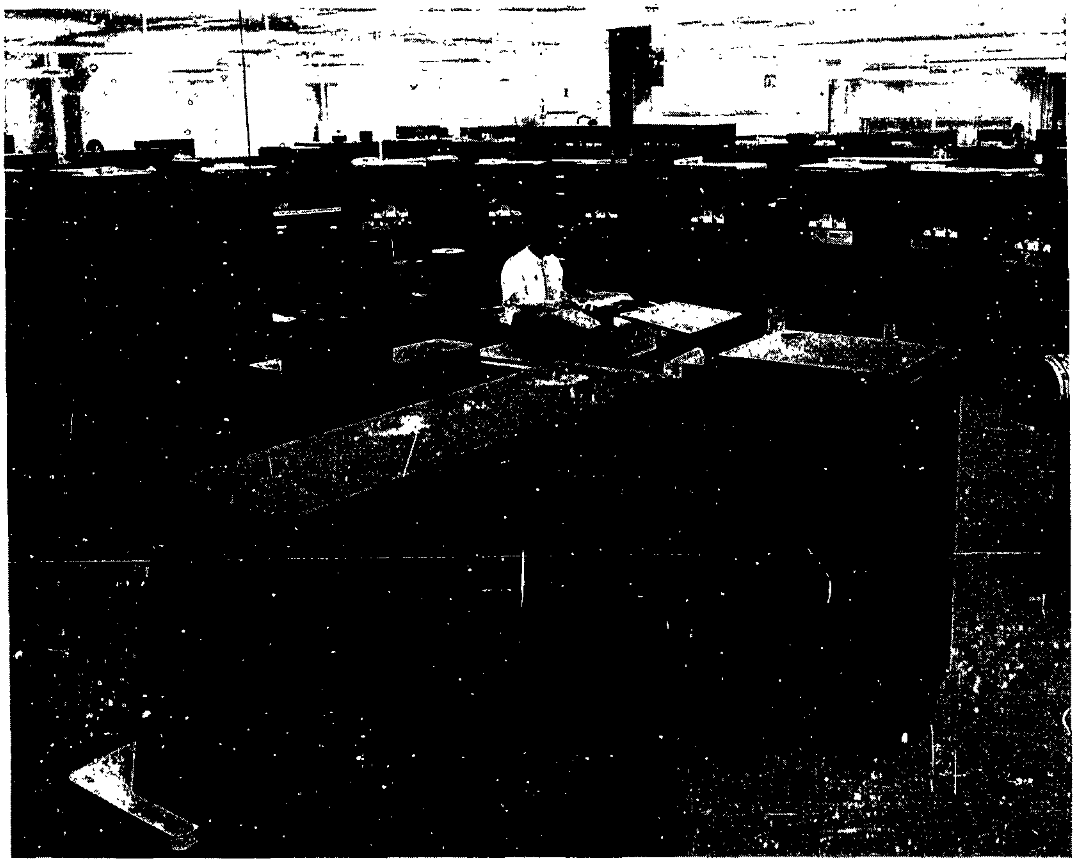


Photo by Lockheed Aircraft Corporation, Sunnyvale

The entire computer area has its own refrigerated air-conditioning system plus humidity control. Air conditioning equipment located in separate, fire-proof, building constructed for the expressed purpose of housing same. Building housing equipment located approximately 15 feet away from building housing the computer equipment.

NAFE FAA

Power, computer	89 Kw	160 KVA	0.765 pf
600 amps max. capacity			
Power, air cond		0.765 pf	15% Excess
Volume, computer		24,000 cu ft	

Area includes 16' x 30' customer eng'r area. Card room not included.

Volume, air conditioner	4,800 cu ft

Machinery, comp. heat exchangers, etc.

Area, computer	2,400 sq ft
Area, air conditioner	480 sq ft
Room size, computer	80 ft x 30 ft
Room size, air conditioner	30 ft x 16 ft
Floor loading	200 lbs/sq ft
Capacity, air conditioner	50 Tons

W. W. II Navy Galley completely refurbished to house computer. Removable floor and false ceiling installed. Room insulated. Preliminary air conditioning of power installed prior to computer selection. Additional power and air conditioning installed as required. Duct work above false ceiling. Electric power beneath removable floor. Air conditioning machinery remotely located with only air handling equipment in computer room. Fluorescent lighting throughout. Installation completed September 1959.

CEIR

Power, computer	75 Kw	108.6 KVA	0.70 pf
Power, air cond	10 Kw	12 KVA	0.85 pf
Volume, computer		11,500 cu ft	
Volume, air conditioner		10,000 cu ft	
Area, computer		1,150 sq ft	
Area, air conditioner		1,000 sq ft	
Room size, computer		25 ft x 40 ft	
Room size, air conditioner		25 ft x 40 ft	
Floor loading		30 lbs/sq ft	
		125 lbs concen max	
Capacity, air conditioner		120 Tons	
Weight, computer		34,370 lbs	
Weight, air conditioner		27,000 lbs	

This A/C equipment handles both 704 and 709. False ceiling. Plenums - modular floor in 2 ft x 4 ft sections, 6 inches clearance between floor and plenum.

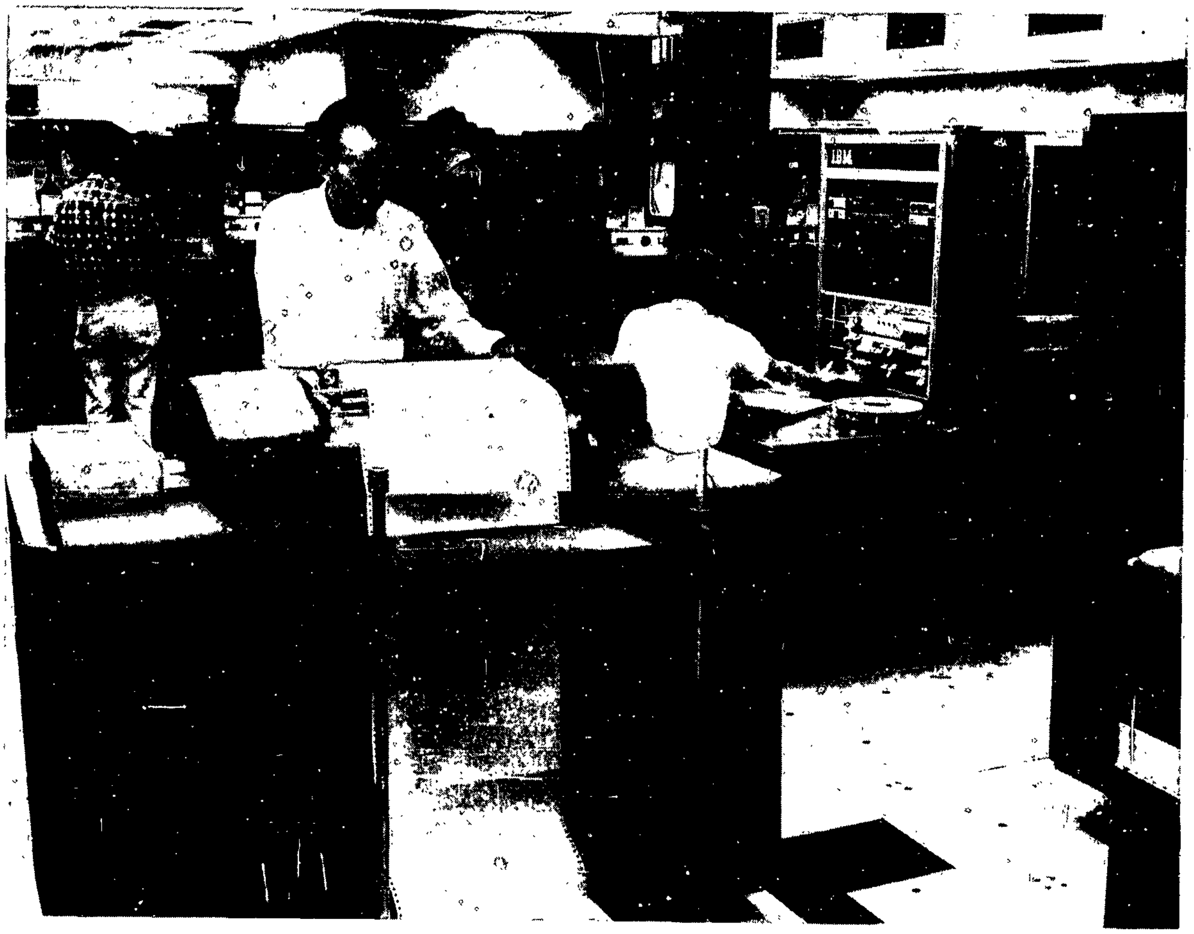


Photo by McDonnell Aircraft Corporation

Douglas

Power, computer	150 KVA
Area, computer	1,500 sq ft
Area, air conditioner	1,200 sq ft
Room size, computer	30 ft x 50 ft
Floor loading	16 lbs/sq ft
	200 lbs concen max
Capacity, air conditioner	40 Tons
Weight, computer	23,000 lbs

Sealed area, a/c ducts installed with 500 RCE/sink for each component, a/c unit and airfilter installed, motor generator set with transformer and controls.

Douglas

Power, computer	150 KVA
Area, computer	1,500 sq ft
Area, air conditioner	1,200 sq ft
Room size, computer	30 ft x 50 ft
Floor loading	16 lbs/sq ft
	200 lbs concen max
Capacity, air conditioner	40 Tons
Weight, computer	22,000 lbs

Sealed area, six inch raised floor installed over power cables, a/c unit and airfilter installed, motor generator set with transformer and controls.

Hughes

Power, computer	205 Kw	256 KVA	0.80 pf
M. G. set			
Power, air cond	99 Kw	120 KVA	±0.82 pf
Induction motor driven			
Volume, computer		23,496 cu ft	
Volume, air conditioner		14,160 cu ft	
Area, computer		1,958 sq ft	
Area, air conditioner		1,180 sq ft	
Room size, computer		42 ft x 46 ft 9 in	
Room size, air conditioner		33 ft 10 in x 34 ft	
Floor loading		100 lbs/sq ft	
		1,000 lbs concen max	
Capacity, air conditioner		70 Tons	
Weight, computer		33,460 lbs	

IBM Space

Power, computer	183.9 KVA
4 wire 208V - 3 phase 800 amp supply	
Power, air conditioner	92.6 KVA
3 wire 208V - 3 phase Four 30 H. P. Compressors	
Volume, computer	30,294.9 cu ft
Volume, air conditioner	13,221 cu ft
Area, computer	3,029.49 sq ft
Area, air cond (2 rooms)	1,469 sq ft
Room size, computer	48 ft 6 in x 62 ft
Room size, boiler room	30 ft x 20 ft
Room size, compressor room	21 ft x 37 ft 6 in

Photo by Phillips Petroleum Company

Floor loading	1,000 lbs/sq ft
Capacity, air conditioner	120 Tons (bldg.)
	47 Tons (709 Machine)
Weight, computer	51,820 lbs (computer & all component equipment)

Air conditioner is installed on basement slab.

Ceilings are 2 x 4 with rock lath and mineral block, hung type.

Building type - steel reinforced and masonry.

Building modifications - complete job on original accupancy.

Power Distribution: 1,200 amps, 3 phase, 4 wire, 120/208V - Bldg. load; 800 amps, 3 phase, 4 wire, 120/208V - machine load.

Lockheed Burbank

Volume, computer	12,500 cu ft
Area, computer	1,250 sq ft
Room size, computer	25 ft x 50 ft
Floor loading	34,650 lbs
Capacity, air conditioner	90 Tons
	313,000 BTU
Weight, computer	34,650 lbs

The area has a raised floor which carries the cold air to the computer and a false ceiling which returns the hot air from the computer, back to the air conditioning units which then cools it and forces back to the computer. The raised floor also holds the interconnecting cables of the computer.

Lockheed Sunnyvale

Power, computer	337 KVA	0.90 pf
Available transformer power		
Power, air conditioner	101 Kw	
Power requirement for 100% operation		
Volume, 2 709's & periph equip	96,000 cu ft	
Volume, transformer, chiller, blower, precipptators, etc.	27,000 cu ft	
Area, computers	8,725 sq ft	
Area, air conditioning	1,200 sq ft	
Room size, computers	112 ft x 72 ft	
Room size, air conditioning	33 ft x 33 ft	
Floor loading	93 lbs/sq ft	
	80 lbs/sq ft con max	
Capacity, air conditioning	125 Tons	
Weight, computers	94,310 lbs	
Weight, air conditioning	20,000 lbs	

One foot raised floor (sheet metal sandwich with wood core flooring) steel frame. 11 ft. high (from raised floor) suspended ceiling, supply air ducted - return not ducted (ceiling plenum) tilt up reinforced concrete walls.

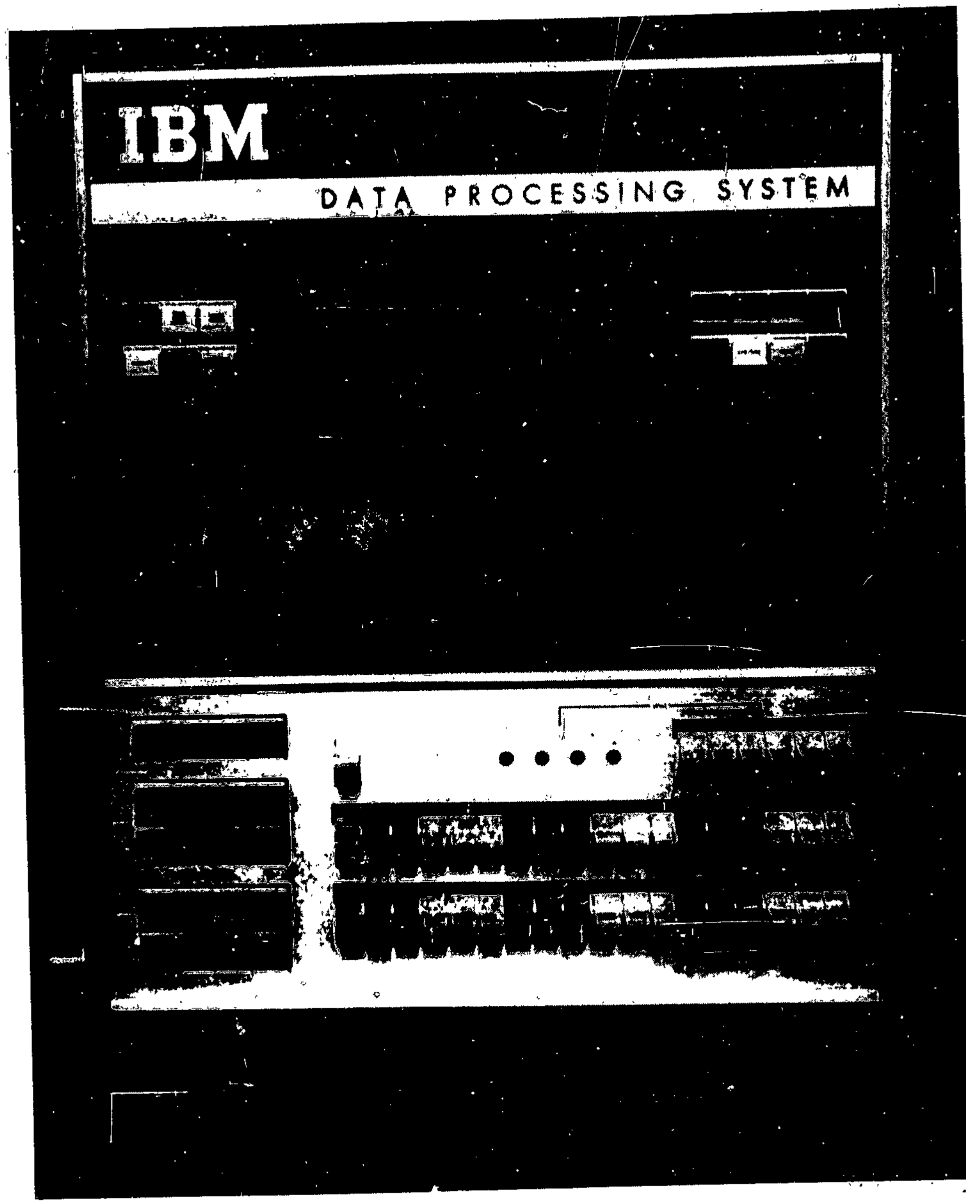


Photo by System Development Corporation

Martin Baltimore

Power, computer	225 KVA supplied, 144 req.	0.80 pf
Power, air cond	70 Kw	0.84 pf
Volume, computer	51,200 cu ft	
Volume, air conditioner	6,400 cu ft	
Area, computer	2,560 sq ft	
Area, air conditioner	640 sq ft	
Floor loading	200 lbs/sq ft	
Capacity, air conditioner	50 Tons operational	
	10 Tons standby	
Weight, computer	38,670 lbs	

System was installed in a balcony area of the building, thus eliminating the advantage of a plenum. The floor was reinforced to suit loadings and covered with vinyl. All walls are insulated and provided with a moisture. Power for the computer is supplied from a dual source 13,200 volt to the operating requirement (208V) thus insuring the stability required. Power for the air conditioning is supplied from the plant supply.

Martin Orlando

Power, computer	104 Kw	174.7 KVA	1.0 pf
Includes peripheral equipment			
Power, air conditioner	50.8 Kw		
Volume, computer	19,000 cu ft		
Volume, air conditioner	9,600 cu ft		
Area, computer	1,900 sq ft		
Area, air conditioner	800 sq ft		
Room size, computer	38 ft x 50 ft		
Room size, air conditioner	40 ft x 20 ft		

Photo by University of California, LRL Livermore

Floor loading 26 lbs/sq ft
875 lbs concen max
Capacity, air conditioner 67.2 Tons
Weight, computer 49,220 lbs
Special raised pedestal type floor. Trade name - Belair.

McDonnell

Power, computer 171 KVA
Area, computer 5,617 sq ft
Floor loading 100 lbs/sq ft
100 lbs concen max
Capacity, air conditioner 37 Tons
Weight, computer 55,640 lbs

Northern States

Power, computer 191 KVA
Volume, computer 38,400 cu ft
Area, computer 3,200 sq ft
Capacity, air conditioner 100 Tons
Weight, computer 31,810 lbs
New building, built in 1957, cement block and brick construction, computer and auxiliary room installed with floating floor, manufactured by Floating Floors Inc., New York. Honeywell climate control regulates temperature and humidity.

Phillips

Volume, computer 23,072 cu ft
Volume, air conditioner 1,512 cu ft
Area, computer 2,884 sq ft
Area, air conditioner 189 sq ft
Capacity, air conditioner 60 Tons
Raised floor, free access - installed in office building.

RCA Moorestown

Power, computer 525.2 Kw 188.2 KVA 447,610 BTU's
Volume, computer 21,600 cu ft
Area, computer 2,160 sq ft
Room size, computer 72 ft x 30 ft
Capacity, air conditioner 75 Tons
Used for complete area. Entire building air conditioned.
Special heavy steel building included area sealed off from remainder for electrical shielding purposes. Raised floor (12 inches) on extruded aluminum over concrete base floor. Computer receives cooled room air (not underfloor plenum). Separate power distribution within building.

RCA Patrick AFB

Power, computer 103.8 Kw	154.1 KVA	0.67 pf
Power, air cond	56.2 Kw	
Volume, air conditioner	4,500 cu ft	
Area, computer	2,800 sq ft	
Area, air conditioner	450 sq ft	
Room size, computer	40 ft x 70 ft	
Room size, air conditioner	20 ft x 20 ft 5 ft x 10 ft	
Capacity, air conditioner	44 Tons	
Weight, computer	45,690 lbs	
Weight, air conditioner	10,000 lbs	

Computer room has false floor with removable sections 2.5 feet square. Air conditioning ducts are above false ceiling. Indirect chilled water system for air conditioning.

RCA Canaveral

Power, computer 113.6 Kw	158.9 KVA	0.72 pf
Power, air conditioner	78.3 Kw	
Volume, computer	11,000 cu ft	
Volume, air conditioner	4,500 cu ft	
Area, computer	2,472 sq ft	
Area, air conditioner	450 sq ft	
Room size, computer	39 ft x 56 ft 9 ft x 32 ft Adjoining "L"	
Room size, air conditioner	15 ft x 15 ft 15 ft x 15 ft	
Capacity, air conditioner	84 Tons	
Weight, computer	43,130 lbs	
Weight, air conditioner	10,000 lbs	

Concrete block building, false floor in machine room for cables, terminal rack for real time inputs and communications, fast acting switch to transfer critical power input to the industrial bank during power fluctuations, and direct expansion system for air conditioning.

Space Tech Labs (2)

Power, computer	160 KVA
Volume, computer	20,000 cu ft
Area, computer	2,000 sq ft
Floor loading	80 lbs/sq ft
Weight, computer	50,000 lbs

24 inch false ceiling and 18 inch raised floor.

System Development Corp

Power, computer 212 Kw M/G fed	235 KVA	0.90 pf
Power, air cond 69 Kw 372 KVA full load rating	78.5 KVA	0.88 pf
Volume, computer	29,400 cu ft	
Volume, air conditioner	63,000 cu ft	
Area, computer	4,200 sq ft	
Area, air conditioner	2,528 sq ft	
Floor loading	250 lbs/sq ft 1,000 lbs concen max	
Capacity, air conditioner	400 Tons	
Weight, computer	54,000 lbs	

False ceiling, seven foot plenum, and concrete block building.

MIT

New building, false floor, 1 foot deep wiring plenum. False ceiling for air ducts and lighting conduits. Building concrete block, aluminum-foil-backed gypsum board interior to reduce water vapor intrusion. Power from new sub-station from 4160 volt building distribution system. Floor loading 125 lbs/sq ft special point loads handled by extra steel. False floor 1 1/4 inch plywood on light steel frame.

UCLRL

Power, computer 192 Kw	134 KVA	0.70 pf
Power, air cond 32 Kw	22 KVA	0.90 pf
Volume, computer	1,060 cu ft	
Volume, air conditioner	2,000 cu ft	
Area, computer	250 sq ft	
Area, air conditioner	360 sq ft	
Room size, computer	25 ft x 40 ft	
Room size, air conditioner	12 x 30 x 10 ft	
Floor loading	900 lbs concen max	
Capacity, air conditioner	30 Tons (nominal)	
Weight, computer	16,000 lbs	
Weight, air conditioner	16,000 lbs	

UCLA

Power, computer	250 KVA
Area, computer	4,700 sq ft

Class A building containing 25,000 square feet built especially to house computer and staff. Computer area incorporates false floor and ceiling plenum chambers, custom designed power connections, etc.

PRODUCTION RECORD

Manufacturer

Delivery on availability basis only.

COST, PRICE AND RENTAL RATES

Manufacturer

Type	Description	Model	Monthly Charge	Purchase Price
709	Central Process Unit	1	$10,000	$500,000
711	Card Reader	2	800	32,000
716	Printer	1	1,200	54,200
721	Card Punch	1	600	25,000
729	Magnetic Tape Unit	1	700	27,500
733	Magnetic Drum Storage	1	2,900	110,000
733	Magnetic Drum Storage	2	2,900	110,000
736	Power Supply	2	1,100	57,200
737	Magnetic Core Storage	3	3,700	192,400
737	Magnetic Core Storage	4	3,700	192,400
738	Magnetic Core Storage	1	19,700	940,000
740	CRT Recorder	1	2,450	96,000
741	Power Supply	2	1,400	72,800
741	Power Supply	3	1,400	72,800
746	Power Distribution Unit	2	1,400	72,800
746	Power Distribution Unit	3	1,300	67,600
755	Tape Control	1	1,500	90,000
766	Data Synchronizer	1	3,600	190,000
780	CRT Display	1	400	16,000

Monthly Rental, average system: $55,200 and up
Selling Price, average system: $2,630,000 and up
Maintenance contract available.

USA EPG Fort Huachuca

Rental rate for basic system is $68,900 per month.
Rental rate for additional equipment is $11,300 per month.
Maintenance is included in rental costs.

USN PMR Pt Mugu

On-line rentals are:

1	709	$48,130.00
13	Tape drives at $700	9,100.00
1	Card Reader	800.00
1	Card Punch	600.00
1	Printer	1,225.00
	Total monthly rental	$59,855.00

Off-line rentals are:

2	010 at $10	$ 20.00
3	024 at $40	120.00
9	026 at $60	540.00
4	Verifiers at 50	200.00
1	Sorter	55.00
1	Tabulator	1,002.50
1	Collator	247.00
1	Reproducer	204.00
1	Interpreter	216.00
1	Tape-to-Card	2,375.00
1	Card-to-Tape	3,365.00
1	Tape Printer (hi speed)	5,330.00
	Total monthly rental	$13,674.50

USN PMR Pt Mugu

Basic system

8K, 3 Data Synchronizers, 6 tapes rent for $42,905.

Peripheral Equipment rents for $3,450.

USN OTS China Lake

Basic system rents for $64,490 per month.

Electric Accounting Machines rent for $3,260/month.

NAFE FAA

Types 709, 711, 716, 721, 729I, 736, 738, 741, 746, 755, 766, and 776 rent for $50,450.

Types 714, 717, 757, 759, and 729I rent for $5,750 per month.

CEIR

Basic system

709, 711, 716, 721, 729 (10), 755 (2), 766, 738, 736, 741, and 746 cost $2,014,900.

Additional equipment

774, 720, 714 also included with 704 cost $441,000.

709, 711, 716, 721, 729 (10), 755 (2), 766, 738, 741, and 746 rent for $50,075.

777, 720, and 714 rent at $12,707.

Standard IBM rental maintenance.

Douglas

Main frame, 13 magnetic tape units, 1 printer, 1 card reader, 1 card punch, and 28,672 words additional core memory rent at $52,000/month.

Douglas

Main frame, 10 magnetic tape units, 1 printer, and 28,672 words additional core memory rent at $51,000 per month.

Ford

Basic system rents for approximately $50,000/month including about $2,000/month for off line printer.

Hughes

Machine Type	No. of Units	Monthly Rental
709	1	$10,000
711	1	800
714 714	1	1,675
716	1	1,200
717	2	2,800
721	1	600
729	13	9,100
736	1	1,100
738	1	19,700
741	1	1,400
746	1	1,300
755	1	1,500
757	1	650
757	1	740
759	1	990
766	1	3,600
	Total	$57,155

Lockheed Burbank

With 32K core memory and 11 tapes, system rents at $450 per hour.

Additional Equipment

714	$22	per hour
722	16	per hour
720	34	per hour

The 709 (32K core, 11 tapes) rents at $49,825 per month, base shift.

Additional Equipment

714	$3,200	per month base shift
720	4,950	per month base shift
722	2,300	per month base shift

Lockheed Sunnyvale

Type	Description	Monthly Rental	Hourly Rate	Extra Shift per Hour
709	C.P.U. w/clock	$10,165	$57.76	$23.11
736	Power Supply	1,100	6.25	2.50
738	Core Memory	19,705	111.96	44.78
741	Power Supply	1,400	7.95	3.18
746	Power Dist.	1,300	7.39	2.96
766	Data Synch.	3,830	21.76	8.70
766	Data Synch. Mod.	125	.71	.28
A	Total Main Frame	37,625	213.78	85.51
755	Tape Control	1,500	8.52	3.41
755	Tape Control	1,500	8.52	3.41
729	Tape Units (12)	8,400(12)	47.72 (12)	19.09(12)
711	Card Reader	800	4.54	1.82
716	Printer	1,200	6.82	2.73
721	Card Punch	600	3.41	1.36
9307	Paper Tape I/O	1,300	7.39	2.96
B	Total On Line	15,300	86.92	34.78
	Total 709 (A + B)	$52,925	300.70	120.29
720A	Printer	1,950	11.08	4.43
727	Tape Unit	550	3.12	1.25
760	Control	2,500	14.20	5.68
	Total Printer 1	5,000	28.40	11.36
722	Card Punch	875	4.97	1.98
727	Tape Unit	550	3.12	1.25
758	Control	850	4.83	1.93
	Total Tape to Card	2,275	12.92	5.16
714	Card Reader	1,650	9.38	3.75
727	Tape Unit	550	3.12	1.25
759	Control	975	5.54	2.22
	Total Card to Tape	3,175	18.04	7.22
729	Tape Unit	700	3.98	
C	Total Off Line	$11,150	$63.34	$23.74
	Total System 1 (A+B)	$64,075	$364.04	$144.03

The 766 Data Synchronizer Mod. is used to handle paper tape I/O.

The 9307 consists of 9307 Paper Tape Read Punch and 9807 Reader Punch Control.

Monthly rental includes 10% F. E. T. where applicable)

Hourly rate is 1/176th of monthly rental.

Extra shift per hour is 40% of 1/176th of monthly rate.

Type	Description	Monthly Rental	Hourly Rate	Extra Shift per Hour
709	C.P.U. w/clock	$10.050	$57.10	$22.84
736	Power Supply	1,100	6.25	2.50
738	Core Memory	19,700	111.93	44.77
741	Power Supply	1,400	7.95	3.18
746	Power Dist.	1,300	7.38	2.95
766	Data Synch.	3,600	20.45	8.18
A	Total Main Frame	$37,150	$211.06	$84.42
755	Tape Control	1,500	8.52	3.41
755	Tape Control	1,500	8.52	3.41
729	Tape Units (12)	8,400(12)	47.72(12)	19.09(12)
711	Card Reader	800	4.54	1.82
716	Printer	1,200	6.82	2.73
721	Card Punch	600	3.41	1.36
B	Total On Line	$14,000	$79.53	$31.82

Total 709 (A+B)	$51,150	$290.59	$116.24
720A Printer	1,950	11.08	4.43
729 Tape Unit	700	3.98	1.59
760 Control	2,500	14.20	5.68
Total Printer 2	5,150	29.26	11.70
C Total Off Line	$5,150	$29.26	$11.70
Total System 2 (A+B+C)	$56,300	$319.85	$127.94
Total Installation (709 Systems 1 + 2)	$120,375		
010 Key punch	$11.00	$ .06	$ .03
026 Key punch	66.00	.37	.19
026 Key punch	71.00	.40	.20
026 Key punch	77.00	.44	.22
026 Key punch	71.50	.41	.20
026 Key punch	71.50	.41	.21
026 Key punch	71.50	.41	.20
056 Verifier	60.50	.34	.17
056 Verifier	60.50	.34	.17
056 Verifier	55.00	.31	.15
Total Key punch	$615.50	3.49	1.74
082 Sorter	68.20	.39	.20
085 Collator	154.00	.87	.44
407 Acctng. Machine	915.75	5.20	2.60
519 Reproducer	161.70	.92	.46
519 Reproducer	178.20	1.01	.50
557 Interpreter	192.50	1.09	.55
Total Auxiliary	$1,670.35	$9.48	$4.75
Total Unit Record	$2,285.85	$12.97	$6.49
Total Sunnyvale Installations	$122,660.85		

Palo Alto

Type	Description	SN	Monthly Rental	Hourly Rate	Extra Shift per Hour
	Univac	22	$20,980.00	$119.20	$59.60
	Core Storage		4,500.00	25.57	12.79
	Float Point		1,545.00	8.78	4.39
	Variable Block		290.00	1.65	.83
A	Total Main Frame		27,315.00	155.20	77.61
	Uniservo (10)		3,200.00(10)	18.18(10)	9.09(10)
	Read Punch		890.00	5.06	2.53
B	Total On Line		4,090.00	23.24	11.62
	Total EDP 22 (A+B)		$31,405.00	$178.44	$89.23
	Univac	27	20,980.00	119.20	59.60
	Core Storage		4,500.00	25.57	12.79
	Floating Point		1,545.00	8.78	4.39
	Variable Block		290.00	1.65	.83
C	Total Main Frame		$27,315.00	$155.20	$77.61
	Uniservo (10)		3,200.00(10)	18.18(10)	9.09(10)
	Read Punch		890.00	5.06	2.53
D	Total On Line		$4,090.00	$23.24	$11.62
	Total EDP 27 (C+D)		$31,405.00	$178.44	$89.23
	High Speed Printer		3,300.00	18.75	9.38
	High Speed Printer		3,300.00	18.75	9.38
	Card to Tape		2,605.00	14.80	7.40
D	Total Off Line		9,205.00	52.30	26.16
	Total EDP Systems (A+B+C+D+E)		$72,015.00	$409.18	$204.62
026	Key punch		77.00	.43	.22
026	Key punch		71.50	.41	.20
026	Key punch		71.50	.41	.21
056	Verifier		60.50	.37	.19
A	Total Key punch		$280.50	$1.62	$.82
077	Collator		126.50	.72	.36
082	Sorter		68.20	.39	.20
407	Acctng. Machine		915.75	5.20	2.60
519	Reproducer		178.20	1.01	.51
552	Interpreter		99.00	.56	.23
B	Total Auxiliary		$1,387.65	$7.88	$3.90
	Total EAM (A+B)		$1,668.15	$9.50	$4.72
	Total Palo Alto		$73,683.15		

Martin Baltimore

709 System - 10 tapes (on line), CRT, Punch, Card Reader, Printer, 2 tapes (off line), Card Punch & Reader, Printer $63,350/month.

3 Hand Punches, 3 Key Punches, 2 Verifiers, Sorter, Collator, Tabulator, 2 Reproducing Punches, Interpreter, Cardatype Tape Punch $2,368/month.

Total system rents for $385/hour.

Off line Card Punch	20/hour
Off line Printer	35/hour
Off Line Reader	30/hour

Martin Orlando

		Qty	Monthly Rental Total
709	Central Processing Unit	1	$10,090
729	Mod. I Tape Units	13	5,100
711	Card Reader	1	800
738	Magnetic Core Storage	1	19,705
755	Tape Control Unit	2	3,000
766	Data Synchronizer	1	3,830
716	Printer	1	1,200
721	Punched Card Recorder	1	600
776	Tape Switching Device	1	75
736	Power Supply	1	1,100
741	Power Supply	1	1,400
746	Power Distribution Unit	1	1,300
714	Card Reader	1	1,500
759	Card Reader Control Unit	1	915
720A	Printer	1	1,900
760	Printer Control & Storage	1	2,500
774	Tape Data Selector	1	2,300
747	TDS Power Supply	1	500
		Total	$57,815

McDonnell

The 709 with 11 tapes, card reader, card punch, on-line printer, and one data synchronizer cost $2,421,300 and rents at $50,560/month.

The 717, 757, 727's, 722, 758, 720, 760, 714, 759, 9701, 9702, 024, 026, 056, 046, 082, 077, 519, 552, and 407 cost $741,800 and rents at $19,650/month.

Northern States

		Qty	Monthly Rental	Price
709	Central Processing Unit	1	$10,000	$500,000
711	Card Reader	1	800	32,000
716	Printer	1	1,200	54,200
721	Card Punch	1	600	25,000
729	Tape Units	13	9,100	357,500
736	Power Unit	1	1,100	57,200
737	Core Storage	2	7,400	384,800
741	Power Unit	1	1,400	72,800
746	Power Unit	1	1,300	67,600
755	Tape Control	2	3,000	180,000
766	Data Synchronizer	1	3,600	190,000
	Total Computer		39,500	1,921,100
714	Card Reader	1	2,960	127,650
722	Card Punch	3	5,850	292,500
720A	Printer	3	14,850	666,600
408	Printer	1	1,273	70,500
407	Printer	1	899	43,750
024	Keypunch	14	924	27,300
026	Printing Keypunch	4	380	12,000
056	Verifier	6	330	14,400
083	Sorter	2	250	12,400
085	Collator	1	138	7,700
101	Statistical Sorter	2	924	48,000

519	Reproducer	5	1,155	32,750
557	Interpreter	6	1,735	92,040
			31,668	1,447,590

Phillips

The 709, 711, 714, 716, 717, 720 II, 721, 722, 13-729's Mod 1, 736, 2-737's, 741, 2-755's, 757, 758, 759, 760, 766, 746 monthly rental, excluding taxes, prime shift is $50,460.

RCA Moorestown

Type	Description	Qty	Monthly Rental
709	Central Processing Unit	1	$10,000
711	Punch Card Reader	1	600
716	Alphabetical Printer	1	1,200
721	Punch Card Recorder	1	600
729	Magnetic Tape Unit (700)	12	8,400
755	Tape Control Unit (1,500)	2	3,000
738	Magnetic Cone Storage	1	19,700
740	Control Output Recorder	1	2,450
780	Display Unit	1	400
736	Power Frame No. 1	1	1,100
741	Power Frame No. 2	1	1,400
746	Power Distributor Unit	1	1,300
766	Data Synchronizer (3,600)	2	7,200
714	Card Reader	1	1,075
759	CD Reader Control	1	975
720	Printer	1	1,000
760	Control & Storage Unit	1	7,500
722	Card Punch	1	800
758	CD Reader Control	1	975

RCA Patrick AFB

The 026 Key punch, 709 CPU, 716 Printer, 727 Mag Tape, 736 Power, 711 Card Rdr, 721 Punch, 729 Mag Tape (12), 737 Core Storage (2), 741 Power, 755 Tape Ctrl, 776 Tape SW, 746 Power, and 766 Data Syn rents at $40,285/month.

The 714 Card Rdr, 757 Control, 9200 Converter, 717 Printer, and 759 Control rents at an additional $8,325/month.

RCA Canaveral

The 709 CPU, 716 Printer, 729 Mag tape (8), 737 Core Storage (2), 711 Card Rdr, 721 Punch, 736 Power, 741 Power, 746 Power, 766 Data Synch (3), 755 Tape Ctrl (2) and 776 Tape SW rent at $43,650/month.

The 717 Printer, 024 Key punch, 407 Acctg Mach, 548 Interpreter, 757 Control, 047 Tape to Card, and 519 Reproducer rent at an additional $3,343/month.

Space Tech Labs (2)

Cost of installation would be $2,558,800 each.

Monthly rental is $53,900 per month. System is rented.

System Development Corp

32K memory, 2 DSU's, 4 TCU's, 20 mag. tapes, reader, punch, printer rent at $70,000/month for 176 hours.

717 Print System, 714 Card Read System, (2) 722 Punch Systems rent at $11,500/month for 176 hours.

MIT

Type	Description
709	Central Processing
711	Punch Card Reader
716	Alphabetic Printer
721	Punch Card Recorder
729 x 10	Magnetic Tape Unit
736	Power Frame 1
738	Magnetic Core Storage
740	Cathode Ray Tube Recorder
741	Power Frame 2
746	Power Distribution
755 x 2	Tape Control Unit
766	Data Synchronizer
780	Cathode Ray Tube Display

Total cost $2,526,670.

Total rental $52,765/month.

714	Card Reader
717	Printer
720	Printer
722	Card Punch
729 x 2	Magnetic Tape Unit
757	Printer Control
758	Card Punch Control
759	Card Reader Control
760	Control Storage
776	Special EDPM Unit

Total cost $593,975.

Total rental is $12,445/month.

The system is rented.

UCLA

Basic system and peripheral equipment is on loan rent-free. The maintenance is donated.

PERSONNEL REQUIREMENTS

Manufacturer

Education, training, program testing, technical assistance on all phases is available.

USA BMA Redstone

	One 8-Hour Shift
Supervisors	1
Programmers	49
Clerks	10
Librarians	1
Operators	2
Engineers (IBM)	5
In-Output Oper	1

Two operators required for each additional extra shift.

Day shift is monitor run on 709.

Operators are used on 704's, 705, and 709 - rotating shifts. Other personnel on 8 hours shift.

Engineers rotate shifts on 704's and 709.

Operation tends toward open shop.

USA EPG Fort Huachuca

	One 8-Hour Shift Used	Two 8-Hour Shifts Recomm	Three 8-Hour Shifts Recomm
Supervisors	1	2	3
Librarians	1	1	1
Operators	1	2	3
In-Output Oper	2	3	4
Tape Handlers	1	2	3

Operation tends toward closed shop.

Methods of training used includes formal classroom training with about 50% on-the-job training interspersed over a 5 week period. Continuous on-the-job training and routine of operators.

Personnel figures shown above do not include personnel in the process of on-the-job training.

All operating personnel are military, therefore, turnover is very heavy.

USN PMR Pt Mugu

	Two Shifts
Supervisors	4
Analysts	5
Programmers	15
Coders	5
Clerks	2
Librarians	2
Operators	11

IBM supplies engineers (generally 3). In addition to the above, there are about 12 people in the machine room doing key-punching, routine sorting, etc. We also have a Systems Group of about 8 programmers who are building their own, special purpose operating system.

Our operation is closed shop as regards the actual machine operation, but open shop as regards programming.

We use all the standard training procedures, but depend most heavily on "on-the-job" training for machine operators; and both in-shop courses and supervisory instruction for programmers.

USN PMR Pt Mugu

	One 8-Hour Shift
Supervisors	2
Programmers	4
Clerks	1
Operators	1
Engineers	1

Operation tends toward closed shop.

Operators are trained on-the-job and programmers by informal training from supervisor.

USN OTS China Lake

	1st Shift
Supervisors	1
Analysts-Programmers-Coders	14
Clerks	1
Operators	4
In-Output Oper	6

Two additional operators are used on second 8-hour shift.

Operation tends toward open shop.

Training is in-house. All mathematicians possess BS degree or higher.

NAFE FAA

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	30	30
Clerks	1	1
Librarians	1	1
Operators	2	2
Engineers	1	1
Technicians	2	2
In-Output Oper	1	1

Operation tends toward closed shop.

Methods of training used includes IBM schools for programming, and in-house training for operators.

CEIR

	Total for One 8-Hour Shift U	R	Total for Two 8-Hour Shifts U	R	Total for Three 8-Hour Shifts U	R
Supvr	1	1	2	2	3	3
Program	17	17	17	17	17	17
Clerks	1	1	1	1	1	1
Librar	1	1	1	1	1	1
Operator	1	1	2	2	3	3
In-Outp	1	1	2	2	3	3

For the purpose of this personnel requirement, our staff was cut in half, since our staff operates both a 704 and a 709. We have one dispatcher, program librarian, magnetic tape librarian, etc., to handle both computers.

Operation tends toward open shop.

Operators are given on-the-job training.

Programmers are given a 6-month course evenly divided between formal classes and on-the-job training.

Douglas

	One 8-Hour Shift
Supervisors	1
Analysts-Programmers-Coders	30
Clerks	1
Operators	5

Operation tends toward closed shop.

Own course followed by on-the-job training.

Douglas

	One 8-Hour Shift
Supervisors	3
Analysts-Programmers-Coders	70
Clerks	2
Operators	5

Operation tends toward closed shop.

Own course followed by On-the-job training.

Ford

	One 8-Hour Shift Used	Recommended	Two 8-Hour Shifts Used	Recommended
Supervisors	4	6		
Analysts-Prog	18	30		
Clerks	0	2		
Librarians	0	1		
Operators	12	15	0	3
Technicians	2	3	0	1
In-Output Op	1	1	0	1
Tape Handlers	0	1	0	1

Operation tends toward open shop.

Methods of training used include hiring trained people, on-job training or classes taught by Aeronutronic personnel, and IBM-supplied classes.

Hughes

	First 8-Hour Shift	Second 8-Hour Shift	Third 8-Hour Shift
Supervisors	4	1	
Analysts	7		
Programmers	8	3	1
Clerks	3		
Librarians	1		
Operators	2	1	1

Three shift total is 32.

Operation tends toward open shop.

On-the-job training is given in conjunction with company sponsored classes.

IBM Space

	Three 8-Hour Shifts
Supervisors	5
Analysts	10
Programmers	25
Coders	10
Clerks	5
Librarians	1
Operators	8
Engineers	3
In-Output Oper	3
Tape Handlers	2

Operation tends toward closed shop.

Methods of training used includes formal class instruction in basic programming and machine operation - 3 to 4 weeks, informal class instruction held at Center covering specific system used here, and supervised programming assignments.

Lockheed Burbank

	Three 8-Hour Shifts
Supervisors	4
Analysts	15
Programmers	43
Clerks	2
Operators	7
Engineers	10 (Recommended)

Operation tends toward closed shop.

All new personnel attend a class which covers the use of Fortran and also machine coding. This class lasts about 4 weeks.

Lockheed Sunnyvale

	Three 8-Hour Shifts Used	Recommended
Supervisors	5	6
Programmers	130	
Clerks	2	3
Librarians	2	2
Operators	12	14
In-Output Oper	7	8

Operation tends toward closed shop.

Training is rendered by shift leaders, IBM Customer Engineers, and IBM Applied Science Representatives.

Supervisors includes Supervisor and shift leaders.

Operating analysts function is accomplished by supervisor and shift leaders. Programming is accomplished by separate department from Operations. The number of programmers recommended depends upon the number of functions being performed at LMSD. Scientific, Flight Data Reduction, and Administrative Data are processed on the two IBM 709 computer systems. Coders and programmers are synonymous at LMSD. Tape handlers are included under "Operators".

Martin Baltimore

	One 8-Hour Shift Used	Recommended
Supervisors	4	6
Analysts	2	4
Programmers	13	17
Coders	2	4
Clerks	2	2
Librarians	0	1
Operators	7	8

Two additional operators are required for second 8-hour shift.

Operation tends toward closed shop.

Classes for newcomers given by our own personnel.

Martin Orlando

	Three 8-Hour Shifts Used	Recommended
Supervisors	1	1
Analysts	2	3
Programmers	15	
Librarians	1	
Operators	7	7
Engineers	5	5

Operation is closed shop.

For non-experienced personnel, an on-the-job full time training program of approximately three weeks, plus close supervision for at least six months, is given.

McDonnell

	First 8-Hour Shift U	Recom	Second 8-Hour Shift U	Recom
Supervisors	5	5	1	1
Programmers	31	31		
Librarians	1	1		
Operators	2	2	2	2

Operation tends toward closed shop.

Methods of training used includes initial two-week training course, followed by on-the-job training with an experienced programmer.

Northern States

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	9
Librarians	1
Operators	1
In-Output Oper	7

Four additional operators are required for second 8-hour shift and two additional operators for the third 8-hour shift.

Operation tends toward closed shop.

IBM Programming School and on-the-job training is used.

Phillips

	Total for One 8-Hour Shift	Total for Two 8-Hour Shifts	Total for Three 8-Hour Shifts
Librarians	1	1	1
Operators	1	2	3
In-Output 0	2	3	3
Tape Hand	1	2	2

Above figures includes only operating personnel. Analysts, programmers, coders, etc. operate as a team to serve all computing and EAM systems.

Operation tends toward closed shop.

Training is by lessor of equipment and on-the-job.

RCA Moorestown

	Three 8-Hour Shifts Used	Recommended
Supervisors	4	7
Analysts	3	5
Programmers	17	22
Coders	8	11
Clerks	2	2
Librarians	0.3	0.5
Operators	7	10
Engineers	5	5
Technicians	2	5
In-Output Oper	5	7

Operation tends toward closed shop.

Methods of training used includes in-house, both formal classes and on the job, for both programmers and all operating personnel. We rarely send personnel to the manufacturer's classes. We extensively use individual mentors; each new person comes in at random times of the year, and is separately guided.

This is basically a scientific computing facility, solving engin[illegible]ng problems on missiles and surface radar equipm[illegible] however, we do spare parts lists and drawing i[illegible] as 8% of our total load, using "commercial" programming systems. We use FORTRAN 709 and SOS for engineering computations.

RCA Patrick AFB

	Three 8-Hour Shifts Used	Recommended
Supervisors	7	7
Analysts	12	12
Programmers	24	24
Coders	3	3
Operators	10	10
Engineers	1	1
In-Output Oper	6	6

Operation tends toward closed shop.

Methods of training used includes IBM courses, on-the-job training, and a training manual developed in-house.

RCA Canaveral

	One 8-Hour Shift Used	Recommended
Supervisors	1	2
Analysts	5	5
Programmers	5	5
Secretary	1	1
Operators	3	3
Engineers	2	2

Operation tends toward closed shop.

Methods of training used includes training courses conducted locally by IBM Applied Science representatives, on-the-job training provided by programmers and the more experienced operators, and manuals.

The operation performed at this facility is unique in that personnel must be familiar with the computer system as well as range operations. As a consequence it takes special requirements for personnel to qualify as computer operators, programmers, analysts, and engineers at this facility.

Space Tech Labs (2)

	Three 8-Hour Shifts
Supervisors	10
Analysts	3
Programmers	30
Clerks	1
Librarians	0.5
Operators	5
Engineers	1
Technicians	2
In-Output Oper	1
Tape Handlers	0.5

Above figures are for each system.

Operation tends toward closed shop.
Methods of training used includes IBM local short courses, an internal two-week course, and on-the-job training.

System Development Corp

	Three 8-Hour Shifts
Supervisors	2
Analysts	2
Clerks	2
Operators	15

Operation tends toward closed shop.
Internal formal classroom and on-the-job training are used.

MIT

	Total for One 8-Hour Shift R	Total for Two 8-Hour Shifts U	R	Total for Three 8-Hour Shifts R
Supervisors	2	2	3	4
Librarian	1	1	1	1
Operators	3	4	4	5
Engineers	2	2	2	2
Technicians	1	0	2	2
In-Output 0	2	3	3	4
Tape Handl	2	3	3	4

This computing facility is run as a Laboratory service for any and all members of the research staff. There is no formal distinction of activity such as analyst, programmer, etc. About 70 persons are regular users. There are two small groups, totalling some 15 persons, whose primary role is to write programs and utility systems in support of research projects.
The facility is on a two-shift operation but is staffed for a possible third shift in the future.
The machine is maintained by IBM engineers. Technician help is variously obtained as needed from an activity primarily working on research items.
Operation tends toward open shop.
Methods of training used includes on-the-job instruction by supervisors. Scheduled classes by qualified members of the Laboratory staff are given.

UCLRL

	Seven days/week
Supervisors	1
Programmers	21
Coders	5
Operators	9

Operation tends toward open shop.
Personnel are trained by working with an experienced person.

UCLA

	Total for One 8-Hour Shift	Total for Two 8-Hour Shifts
Supervisors	1	2
Analysts	2	2
Programmers	3	3
Coders	0	0
Clerks	4	4
Librarians	0.5	0.5
Operators	2	4
Engineers	4	4
Technicians	0	0
In-Output Oper	1	1

For two 8-hour shift operation, a full time librarian is recommended. For three 8-hour shifts, three supervisors are recommended.
Operation is open shop programming, closed shop machine operation.
Short Fortran programming classes and apprenticeship system is used.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USA BMA Redstone
Good time 113.1 Hours/Week (Average)
Attempted to run time 116.6 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.969
Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 1 Jan thru 31 Mar 60
Time is not available for rent to outside organizations.

USA EPG Fort Huachuca
Figures based on period 1 Sep 59 to 1 Sep 60
Passed Customer Acceptance Test 1 Feb 59
Time is available for rent to qualified outside organizations.

USN PMR Pt Mugu
Average error-free running period 3.5 Hours
Good time 55.6 Hours/Week (Average)
Attempted to run time 60.4 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.921
Above figures based on period 1 Feb 60 to 29 Feb 60
Passed Customer Acceptance Test 8 Jan 60
Time is available for rent to qualified outside organizations.

USN PMR Pt Mugu
Average error-free running period 7 Hours
Good time 35.2 Hours/Week (Average)
Attempted to run time 37.1 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.948
Above figures based on period 1 Feb 60 to 28 Feb 60
Passed Customer Acceptance Test 15 Aug 59
Time is available for rent to qualified outside organizations.

USN OTS China Lake
Good time 100 Hours/Week (Average)
Attempted to run time 105 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period 1 Apr 60 to 30 Apr 60
Passed Customer Acceptance Test 13 Jan 60
Time is available for rent to qualified outside organizations. Availability is dependent on workload.

NAFE FAA
Average error-free running period 40 Hours
Good time 40 Hours/Week (Average)
Attempted to run time 41 Hours/Week (Average)
Operating ratio 0.98
Above figures based on period from Jan 60 to Apr 60
Passed Customer Acceptance Test Oct 59
Time is not available for rent to outside organizations.

CEIR
Good time 47.5 Hours/Week (Average)
Attempted to run time 50.5 Hours/Week (Average)
Operating ratio 0.94
Above figures based on period 10 Feb 59 to 1 Jan 60
Passed Customer Acceptance Test 10 Feb 59
Time is available for rent to outside organizations.

Douglas
Average error-free running period 6 Hours
Good time 110 Hours/Week (Average)
Attempted to run time 115 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period from Jul 59 to Jul 60
Passed Customer Acceptance Test Feb 59
Time is available for rent to outside organizations.

Douglas
Average error-free running period 6 Hours
Good time 110 Hours/Week (Average)
Attempted to run time 115 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period from Sep 59 to Jul 60
Passed Customer Acceptance Test Sep 59
Time is available for rent to outside organizations.

Ford
Average error-free running period 10 Hours
Good time 95 Hours/Week (Average)
Attempted to run time 101 Hours/Week (Average)
Operating ratio 0.94
Above figures based on period 23 Mar 60 to 23 May 60
Passed Customer Acceptance Test 23 Mar 60
Time is available for rent to outside organizations.

Hughes
Good time 127 Hours/Week (Average)
Attempted to run time 14 Hours/Week (Average)
Operating ratio 0.95
Above figures based on period 16 May 60 to 22 May 60
Passed Customer Acceptance Test Apr 59
Time is available for rent to outside organizations.

Analysis of the 14 hour figure includes: machine failure, rerun time, operator error, time lost due to program failure.

An additional 13 hours down time should be added for preventive maintenance care.

There were 14 hours during this period considered idle time.

IBM Space
Good time 130 Hours/Week (Average)
Attempted to run time 134 Hours/Week (Average)
Operating ratio 0.97
Above figures based on period 1 Mar 60 to 1 Jun 60
Passed Customer Acceptance Test Sep 59
Time is not available for rent to outside organizations.

Lockheed Burbank
Average error-free running period 6 Hours
Good time 126 Hours/Week (Average)
Attempted to run time 148 Hours/Week (Average)
Operating ratio 0.85
Above figures based on period from Jan 60 to Apr 60
Passed Customer Acceptance Test May 59
Time is not available for rent to outside organizations.

Lockheed Sunnyvale
Average error-free running period 31 hours/system
Good time 258.53 Hours/Week (Average)
Attempted to run time 269.71 Hours/Week (Average)
Operating ratio 0.9585
Above figures based on period 1 Jan 60 to 1 Apr 60
Passed Customer Acceptance Test 1-29 Dec 58; 2-4 Aug 59
Time is available for rent to qualified outside organizations.

Statistics are based on elapsed time totals of two (2) 709 systems.

Martin Baltimore
Good time 70 Hours/Week (Average)
Attempted to run time 74 Hours/Week (Average)
Operating ratio 0.94
Above figures based on period from Mar 60 to May 60
Passed Customer Acceptance Test Oct 59
Time is available for rent to outside organizations.

Martin Orlando
Good time 110 Hours/Week (Average)
Attempted to run time 115 Hours/Week (Average)
Operating ratio 0.96
Above figures based on period 1 Jan 60 to 31 May 60
Time is available for rent to qualified outside organizations.

McDonnell
Good time 100 Hours/Week (Average)
Attempted to run time 106 Hours/Week (Average)
Operating ratio 0.941
Above figures based on period 4 Apr 60 to 29 Apr 60
Passed Customer Acceptance Test 3 May 60
Time is available for rent to outside organizations.

Northern States
Good time 99 Hours/Week (Average)
Attempted to run time 106 Hours/Week (Average)
Operating ratio 0.934
Above figures based on period 1 Jun 60 to 30 Jun 60
Passed Customer Acceptance Test May 59
Time is not available for rent to outside organizations.

Phillips
Good time 77 Hours/Week (Average)
Figure based on period 1 Feb 60 to 31 Mar 60
Time is not available for rent to outside organizations.

RCA Moorestown
Good time 115 Hours/Week (Average)
Attempted to run time 138 Hours/Week (Average)
Operating ratio 0.90
Above figures based on period from Jan 60 to Jun 60
Passed Customer Acceptance Test 18 Jun 59
Time is not available for rent to outside organizations.

Excellent operational experience during initial 3 months, poor experience for several months following due to stress placed on computer by excessive humidity, temperature, and power failure conditions.

RCA Patrick AFB
Good time 67 Hours/Week (Average)
Attempted to run time 72 Hours/Week (Average)
Operating ratio 0.93
Above figures based on period 1 Nov 59 to 31 Mar 60
Passed Customer Acceptance Test 8 Jul 59
Time is not available for rent to outside organizations.

Figures are based on production usage only.

RCA Canaveral
Average error-free running period 1 Week
Good time 80 Hours/Week (Average)
Passed Customer Acceptance Test 8 Jan 59
Time is not available for rent to outside organizations.
From 8 Jan 59 to Nov 59 99% reliability
From Nov 59 to May 60 96% reliability

Space Tech Labs (2)
Good time 108 Hours/Week (Average)
Attempted to run time 123 Hours/Week (Average)
Operating ratio 0.88
Above figures based on period from Apr 60 to Jun 60
Passed Customer Acceptance Test Apr 59 and Jan 60
Time is available for rent to qualified outside organizations.

System Development Corp
Good time 120 Hours/Week (Average)
Figure based on period from Dec 59 to Jun 60
Passed Customer Acceptance Test Dec 58
Time is not available for rent to outside organizations.

120 hours/week is defined as available time used, exclusive of all forms of maintenance and down time.

MIT
Good time 84 Hours/Week (Average)
Attempted to run time 86 Hours/Week (Average)
Operating ratio 0.98
Above figures based on period 1 Apr 60 to 1 Aug 60
Passed Customer Acceptance Test 15 Feb 59
Time is not available for rent to outside organizations.

UCLRL
Good time 145 Hours/Week (Average)
Attempted to run time 161 Hours/Week (Average)
Operating ratio 0.90
Above figures based on period from Sep 58 to Jul 60
Time is not available for rent to outside organizations.

UCLA

Average error-free running period 75 Hours
Good time 110.4 Hours/Week (Average)
Attempted to run time 112.5 Hours/Week (Average)
Operating ratio 0.981
Above figures based on period 1 Jan 60 to 31 May 60
Passed Customer Acceptance Test 18 Oct 58
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include high speed, large memory, compatibility with 704 and 7090, and a rich operation code set.

Unique system advantages include overlap input and output operations with computing with very low memory interference rate and convert commands for facilitating Binary-Decimal conversions.

Many special features and attachments are available on "Request for Price Quotation" basis; i.e. clocks, data channel trap, extended precision, direct data device, tape switches, etc.

Recommended procedures for magnetic tape storing, shipping, and protection from humidity, temperature, electrical, fire, or other damage:

Acetate Base Tape:

Storage for frequent usage.
Relative humidity 40 to 60%
Temperature 65 to 80°F.

Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, the following specifications would apply:

Storage for infrequent usage.
Temperature 40 to 120°F.

The tape must be placed in a dust proof container and hermetically sealed in a plastic bag. Before re-using, the tape must be reconditioned by allowing it to remain in the conditioned atmosphere for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours.

Mylar Base Tape:

Storage for frequent or infrequent usage.
Relative humidity 0 to 80%
Temperature 40 to 120°F.

The tape should be stored in a dust proof container. Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, it must be reconditioned by allowing it to remain at the given condition for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours. The upper limits on humidity is given to prevent the formation of fungus and mold growth. This limit may be exceeded by hermetically sealing the tape in a plastic bag.

General Precautions:

The tape should not come in contact with magnetic material at any time and should never be subjected to strong magnetic fields. Either of these can cause the loss of information or the introduction of noise.

When shipping magnetic tape, the reel should be placed in a dust proof container and hermetically sealed in a plastic bag. Additional support should be obtained by enclosing in an individual cardboard box.

USA BMA Redstone

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage are external labels - pressure adhesive, tape cabinet storage, and for humidity, tapes are stored in computer room.

USN PMR Pt Mugu

Outstanding features are entry of digital telemetry data (PDM, FM, and PCM) from analog tapes. Direct entry of remote site radar and COTAR data. Output may also be to x-y plotters or 30 channel oscillograph.

Magnetic tape is stored in computer room for humidity and temperature protection.

USN PMR Pt Mugu

Outstanding features are directly connected plotting boards for display of impact prediction information, direct entry of FPS-16 Radar and AME COTAR Data from remote sites, digital to analog conversion of output/replacing, CRT system, and direct data RPQ on channels B & D.

Unique system advantages include cubic DH14 DMS input 6 channel, radar and/or COTAR information, and direct through channel D with computer interrupt.

Magnetic tapes labelled and stored in computer room for humidity and temperature protection.

USN OTS China Lake

Outstanding features include dual read/write heads on 729 Tape Units and the data synchronizer.

Tapes are stored in standard tape storage cabinets under controlled humidity and temperature conditions.

NAFE FAA

Tapes are stored in containers in the 709 room and thus under temperature and humidity control.

CEIR

Tapes are labelled with Labelon Plastic Tape, they are shipped in special metal cases, they are stored in humidity and temperature controlled rooms, and fire extinguishers are placed throughout machine room and tape room.

Hughes

Outstanding features are high speed and reliability and the data synchronizer for simultaneous input, output, compute.

Tapes are stored in a humidity and temperature controlled storage room.

IBM Space

Outstanding features are data communications channel and direct data modification package to allow for high speed teletype input and specialized output for real-time operations, three channel operation for maximum overlapping operation, internal accounting clock and interval timer, and a tape switching device.

Tapes are stored in air conditioned, non-smoking areas in racks and cabinets. All tapes are numbered and catalogued as used; a punched card tape log is maintained. Little tape shipping is done.

Lockheed Burbank

An outstanding feature is that all work is run under a Monitor System which gives us the maximum usage of the machine.

Lockheed Sunnyvale

Outstanding features include a powerful set of input/output commands, indirect addressing, automatic priority processing, real time input, full word sense indicators, read-compute-write facilities, and a buffered input/output.

Magnetic tape labels are color coded for TTC, CTT, reserved and TTP with written identification and instructions. Some labels are machine printed for repeat jobs. Storage in original plastic containers and in conventional reel cabinets. Tapes are shipped (very little required) in original containers, plastic bag and cardboard cartons. Tapes are retained in the computer room where the temperature and humidity

is maintained at the recommended level. Studies are being made for acquisition of suitable fireproof containers for those tapes requiring special consideration.

System summary:

Binary (36 bits/word)
Single address - parallel operation
3 Index Registers
32,000 words of 12 microsecond access
Fixed and floating point commands
1 to 3 card readers (250 cards/min)
1 to 3 card punches (100 cards/min)
1 to 3 printers (150 lines/min)
Cathode ray display
15,000 char/sec magnetic tape

Martin Baltimore

Tapes are stripped once each month.

Martin Orlando

Tapes are stored in humidity controlled machine room. Protection against damage is maintained by retention file of early cycle master tapes in a remote area.

RCA Moorestown

Outstanding features are that the computer is used in a real-time control loop at the BMEWS Engineering Model Tracking Radar.

All tapes are stored in a computer area, TABCO Storage Bins. Magnetic tapes assigned by usage class, labels removed after printing unless permanent labels are used.

Present peripheral equipment consists of two 720 printers, one 714 card/tape device, and one 722 tape/card punch.

RCA Canaveral

An outstanding feature is the service provided by IBM.

Majority of tapes are classified. They are labelled and stored in a secure walk-in cage which is perforated for air conditioning and humidity control purposes. Label is a 1"x1" sticker.

This installation's primary function is the real time support of ballistic missile launches. Secondly, it is used for data reduction.

FUTURE PLANS

USA EPG Fort Huachuca

IBM 1401 Tape System to replace the present peripheral equipment.

USN PMR Pt Mugu

Future plans provide for the continuing operation of the present computer system and concentration of development effort on the direct linkage of the computer to external instrumentation. The ultimate goal is to minimize the calendar time required to deliver missile test results to the project engineers for evaluation.

USN OTS China Lake

Consideration is presently being given to replacing the IBM 709 with the IBM 7090.

NAFE FAA

In March 1961 the 709 and peripheral equipment will be replaced by an IBM 7090 and 1401 System.

CEIR

An IBM 7090 to replace 709.
An IBM 7090 to be installed in New York, New York.

Ford

IBM 709 to be replaced by IBM 7090. IBM 1401's to be used as peripheral equipment.

IBM 7223 high speed (500 cards/minute) card reader being attached on-line to the 709.

Hughes

Possible acquisition of IBM 7090 EDPM to replace IBM 709. Use of IBM 1401 series for peripheral handling of input-output.

Lockheed Burbank

Delivery of a 7090 Computer is expected. Its configuration will be 16 high speed Mode IV tapes, 32 K Core, On-Line Printer, and On-Line Card Reader.

Lockheed Sunnyvale

Installation of our first IBM 7090 System is scheduled. This consists of a four (4) channel, twenty (20) high density tape transports (62,500 characters per second), card reader, on line printer and on line card punch.

When this system becomes operational, one 709 will be removed.

Installation of the second IBM 7090 System is scheduled for several months later. This second 7090 System consists of the same configuration as the first 7090 System. When this system becomes operational, the second 709 will be removed.

Three IBM 1400 series systems are scheduled for delivery in early 1961. The first 1401 will be a model 1401-C with six tape transports. These systems will be used as input-output devices for the two 7090 Systems and will replace a majority of the off-line peripheral equipment now in use.

We are tentatively planning to make use of magnetic disc memory devices for data and program storage in the IBM 7090 Systems. These auxiliary memories would operate on line to the 7090 for processing runs and would be loaded and unloaded off-line using magnetic tape storage devices.

Martin Baltimore

A 1401 System is to replace our off line equipment. We intend to install a 7090 in the near future.

Martin Orlando

In 1961 an IBM 7070 with 10 tape units plus an IBM 1401 with 4 tape units will be installed to handle our inplant commercial programs. The programs planned for this equipment are as follows:

Master Requirements Program
Shop Order Control Program
Scheduling and Machine Loading Programs (Short Term and Long Range)
Material Control Program
Payroll Program (Hourly and Salary)
Cost Distribution Program (Material and Labor)
Purchase Order Program

McDonnell

An IBM 7090 and two IBM 1401 Systems are scheduled.

Northern States

New components for 1961 include 2 IBM 1401 Model C-3 and 2 IBM 1401 Model D-3. To be retired in 1961 are 1 IBM 714 Card Reader, 3 IBM 720A Printer, and 3 IBM 722 Card Punches.

Phillips

Replacement and intended acquisition of new systems include replacing the IBM 709 with an IBM 7090 and 2 1401's, installation of a Burroughs Model 205 Computer with card I/O (new system). Installation of an additional IBM 650, Model 2, card I/O.

RCA Moorestown

Heavy usage (3.5 shifts) indicates early acquisition of a transistorized machine to reduce work load to one-shift operation. Machine not indicated by name at this time. Probably within one year. Two 1401 Model C Computers are on-order to replace present peripheral equipment.

RCA Patrick AFB

It is currently planned to replace 717 off-line printer with an IBM 1401 System, to replace the present 8,000 word core storage with a 32,000 word unit, and to replace off-line input-output equipment with an IBM 1401 System.

RCA Canaveral

It is currently planned to replace the present 8,000 word core storage with a 32,000 word unit.

Space Tech Labs (2)

Plan to replace both our IBM 709's with our IBM 7090's.

MIT

The 709 will be replaced by a 7090. It will have a third channel and four additional tape drives. Otherwise, it is compatible with the 709. The present off-line equipment will be replaced by two IBM 1401 Systems.

UCLA

1401 System on order for peripheral operations.

INSTALLATIONS

U. S. Army Ballistic Missile Agency
Computation Laboratory, Bldg. 4663
Redstone Arsenal, Alabama

U. S. Army Electronic Proving Ground
Fort Huachuca, Arizona

U. S. Navy Pacific Missile Range
Range Operations Department, Code 3280
Point Mugu, California

U. S. Naval Missile Facility
(Land-Air, Inc.)
Point Arguello, California

U. S. Naval Ordnance Test Station
China Lake, California

National Aviation Facilities Experimental Station
Simulation and Computation Branch
Atlantic City, New Jersey

C-E-I-R, Inc.
1200 Jefferson Davis Highway
Arlington 2, Virginia

Douglas Aircraft Company, Inc., Dept G-318 (2)
3000 Ocean Park Blvd.
Santa Monica, California

Ford Motor Company
Aeronutronic Division
Ford Road
Newport Beach, California

Hughes Aircraft Company
Building 6, Room F1022
Florence Avenue & Teale Street
Culver City, California

IBM Space Computing Center
615 Pennsylvania Avenue, N. W.
Washington, D. C.

Lockheed Aircraft Corporation
Math Analysis Dept.
Burbank, California

Lockheed Aircraft Corporation
Missiles and Space Division, P. O. Box 504
Sunnyvale, California

The Martin Company
Missile Weapons Systems Division
Baltimore 3, Maryland

The Martin Company
Engineering Division
Orlando, Florida

McDonnell Aircraft Corporation
Box 516
St. Louis 66, Missouri

Northern States Power Company
1925 Sather Street
St. Paul 13, Minnesota

Phillips Petroleum Company
Adams Building, Computing Dept.
Bartlesville, Oklahoma

RCA Missile & Surface Radar Division
Building 116-1
Moorestown, New Jersey

RCA Service Company
Technical Laboratory, Bldg. 989
Patrick Air Force Base, Florida

RCA Service Company
Data Processing Division, Bldg. 2-1655
Cape Canaveral, Florida

Space Technology Laboratories, Inc. (2)
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2400 East El Segundo Boulevard
El Segundo, California

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West Los Angeles, California

M. I. T. Lincoln Laboratory
P. O. Box 73
Lexington 73, Massachusetts

University of California L. R. L.
Box 808
Livermore, California

University of California
Western Data Processing Center
Los Angeles 24, California

Texas Engineering Experiment Station
Data Processing Center
College Station, Texas

IBM 1401

IBM 1401 Data Processing System

MANUFACTURER

International Business Machines Corporation

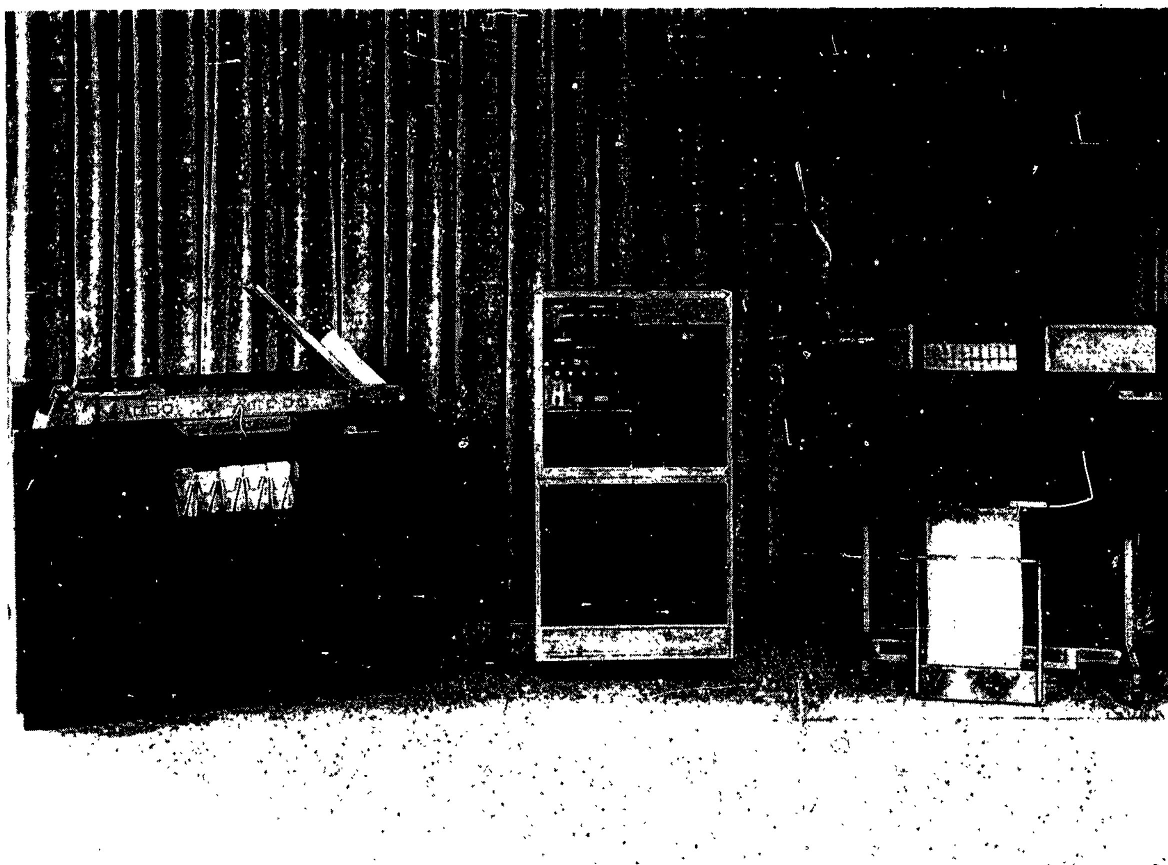


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

System is designed and used for commercial applications, including payroll, railroad freight car accounting, public utility customer accounting, merchandising, and accounts receivable for retailers.

Hickok Manufacturing Co., Inc.

To be located at 850 St Paul Street, Rochester , New York, the system will be used for order processing (packing lists and shipping labels), invoicing, accounts receivable preparation, item sales statistics and forecasting, inventory planning and control, prime cost reports, customer statistics, salesmens territory reports, and hourly payroll.

Western Electric Company, Inc. - Laureldale Plant

Located at Laureldale, Penna., the system will be used for a variety of data processing problems on a one shift basis. Initial plans are to convert major tabulating applications such as payrolls, labor distribution, order accounting and accounting analysis which will require twenty-five percent utilization and effect cost reduction in released punch card equipment and personnel. New applications planned are inventory control, parts explosion, product in-process inventories and results, statistical analyses of product test results, X bar-R chart plotting, and cost bulletin.

Westinghouse Electric Corporation, Steam Division

Located at Lester Branch P.O., Philadelphia 13, Pa., the system is used as off-line equipment auxiliary to 7090, for tape-to-card operations, card-to-tape operations, tape-to-printer operations, card-to-printer operations, etc. In addition, as a computer for small jobs currently done on punched card tabulating equipment.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	Variable length
Decimal digits/instruction	one to eight
Instructions per word	Variable length
Arithmetic system	Fixed point
Instruction type	One or two address

Instruction word format

OP	A/I Address	B Address	d Modifier
X	XXX	XXX	X

OP	(A/I)	B
X	XXX	XXX

OP	(A/I)	d
X	XXX	

OP	(A/I)
X	XXX

OP	d
X	X

OP
X

OP 1 character operation code
A/I 3 character storage address where A is location of a data word or I is address of next instruction
B 3 character storage address of a data word
d 1 character modifier

Automatic coding includes a symbolic programming system.

Registers

I Address Register
A Address Register
B Address Register
A Register
B Register
A Index Register
B Index Register
AB Index Register

A and B Address Registers allow chaining of instructions, i.e., performing a series of operations on several fields that are in sequence in storage. Less time is required to perform the operations and space is saved in storing instructions.

Indexing is part of optional advanced programming feature which also includes abilities to move full records and to store A and B Address Registers for easy program modification.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	300 (8+8 digits)
Mult	1,960 (6x4 digits
Div	2,170 (10/4 digits)

Multiply-Divide times are for the Multiply-Divide feature installed.

1401 is an "Add-to-Storage" system. No additional instructions or time is required to store results.

Arithmetic mode Serial (by character)
Timing Synchronous Asynchronous (depending on function)
Operation Sequential Concurrent (depending on function)

Timing - Operations

Card input/output can often be overlapped with processing.

Print output can be partially overlapped with processing; or can be completely overlapped with print storage installed.

Magnetic tape input/output is not overlapped. Internal processing is serial.

STORAGE

Manufacturer

Media	No. of Alphanum/Char	Access Microsec
Core	1,400; 2,000; 4,000; 8,000; 12,000; 16,000	11.5
Magnetic Disk (Type 1405) Model I	10,000,000	500,000 (Avg)
Magnetic Disk (Type 1405) Model II	20,000,000	500,000 (Avg)

50,000 two hundred character records on 25 discs (Model I).

100,000 two hundred character records on 50 discs (Model II).

Both models have two read-write arms.

Magnetic Tape

No. of units that can be connected	6 Units
No. of chars/linear inch of tape	556 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 to 62,500 Char/sec
Start time	7.3 or 10.8 Millisec
Stop time	7.3 or 10.8 Millisec
Average time for experienced operator to change reel of tape	60 - 120 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Mylar

Two tape units can be specified: 729 II or 729 IV.

Mylar is DuPont's registered trademark for its polyester film.

Westinghouse

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4000 char	6 bits/char, 1 parity bit, 1 word mark bit.	11.5

INPUT

Manufacturer

Media	Speed
Cards (80 column Type 1402)	250 or 800 cards/min
Magnetic Tape (729 II or 729 IV)	15,000 or 62,500 char/sec

Dual density standard

Paper Tape 500 char/sec

Reading is controlled by a panel which decodes the paper tape in binary coded decimal for 5, 6, 7 or 8 channel tape.

Optical Character Reader 290 to 400 documents/min

Cards or documents may be read. Reader is under program control. Characters which may be read are the Type 407 print, .093 inches high. Characters which may be read are the integers 0 - 9, -, 1-, and a Π . Paper or cards must have a horizontal width dimension of 5-7/8 inches minimum to a 8-3/4 inches maximum. The vertical dimensions are 2-3/4 inches minimum to 3-2/3 inches maximum. Option of one or two lines/document. Reading is serial, left to right.

Console Inquiry Station (Type 1407) Manual

Modified IBM Electric Typewriter with a 12 inch carriage, using a continuous form.

Westinghouse

Media	Speed
Magnetic Tape IBM 729 II	75 in/sec
	15,000 or 42,000 char/sec

Character rate varies due to high or low density tape option.

Card Reader	800 cards/min
IBM 1402 Card Read-Punch	

OUTPUT

Manufacturer

Media	
Cards (80 column)	250 cards/min
Magnetic Tape (Type 729 II and 729 IV)	15,000 or 62,500 char/sec
Dual density standard	
Printer	60 lines/min

Westinghouse

Card Punch	250 cards/min
IBM 1402 Card Read-Punch	
Printer	600 lines/min
IBM 1403 Printer	
Magnetic Tape	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity	
Diodes	6,213 - 14,171	(Min. and max. systems)
Transistors	4,315 - 9,805	(Min. and max. systems)
Magnetic Cores		
Type 17:	17,540	Minimum system
Type 24:	200	
Type 17:	129,540	Maximum system
Type 24:	600	
Type 18:	1,120	

CHECKING FEATURES

Manufacturer

Parity and validity checks are made. Programming checks, balances and controls may be made.

1402 Checking

Automatic hole count check between read stations.

Automatic Hollerith Validity check before storage entry.

Automatic hole count check between punch station and read station.

1402 Translation

Automatic card to internal BCD input translation.

Automatic internal BCD to card output translation.

1403 Checking

Automatic parity check of character to be printed.

Automatic validity check of character to be printed.

Hammer action to be performed.

Hammer action performed.

729 II - 729 IV Checking

Vertical parity check by character

Horizontal check by record

Two-gap head verifies validity at the time data is written

Dual-level sensing provides additional checking of tape read and write operations and error-free operation on valid data.

1402 Card Read Punch - Punch feed read and 51/80 column interchangeable read feed.

1403 Printer - print storage.

Input-output - column binary device.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer 2.88 Kw 3.2 KVA min. = Model A
(Max.) 12.15 Kw 13.5 KVA 0.80 to 0.90 pf max. = Model C+6-729s

Power, air condition approx 3 Kw (Min.)
approx 11 Kw (Max.)

The KVA and power factor varies with manufacturer. Minimum system requires 1 Ton, amximum system requires 3 1/2 Tons.

Volume, computer	117.2 cu ft min.
	403.8 cu ft max.
Area, computer	33.8 sq ft min.
	80.8 sq ft max.
Room size	239 sq ft min.
	463 sq ft max.
Floor loading	25 lbs/sq ft
	325 lbs concen max
Volume, air conditioner	6 cu ft - 1 ton unit
	84 cu ft - 5 ton
Area, computer	3 sq ft - 1 ton
	12 sq ft - 5 ton
Capacity, air conditioner	Depends on manufacturer

3 1/2 tons are required for maximum size system, a 5 ton unit would be nearest size available.

Weight, computer	3,063 lbs (Min.)
	11,530 lbs (Max.)

Normal air conditioning will usually be adequate, providing the capacity is available to handle the added B.T.U. of heat generated by the system.

Relatively few restrictions are placed on the arrangement of the 1401 System units.

Electrical requirements - 208 or 230 volts (±10%), 3-phase (4-wire), 60 cycle (± 1/2 cycle).

Environmental requirements

Power On (system operating) temperature 60° - 90°F, relative humidity 20 - 80%, air filtration - 20% minimum by National Bureau of Standards discoloration test for mechanical-type filter.

Power Off (extended non-operational period) temperature 50° - 110°F, relative humidity 0 - 80%.

These environmental requirements are less stringent than those that apply to storage areas for IBM cards and magnetic tape.

It is recommended that instruments capable of recording temperature and humidity be provided.

The 1401 System does not require a raised floor. However, if the rated floor loading of the area in which the system is to be installed is inadequate, certain types of raised floor can serve the purpose of spreading the load evenly over a larger area. Also, the use of a raised floor reduces the possibility of damage to cables and improves the appearance of the installation.

Westinghouse

Power, computer 208 or 230 volts, 60 cycle, 3 phase, 4 wire system.

Power, air conditioner	limited amount needed
Volume, computer	326 cu ft (approx)
Volume, air conditioner	60 cu ft (approx)
Area, computer	70 sq ft (approx)
Area, air conditioner	12 sq ft (approx)
Room size	350 sq ft (approx)
Floor loading	50 lbs/sq ft
	70 lbs concen max
Weight, computer	14,655 lbs
Weight, air conditioner	400 lbs

PRODUCTION RECORD

Number produced to date	Over 2,800
Time required for delivery	24 months

Over 2,800 systems have been sold to date.

COST, PRICE AND RENTAL RATES

Manufacturer

Basic System	Cost	Monthly Rental
IBM 1401 Processing Unit, Model A-1	$ 70,500	$1,200
IBM 1402 Card Read Punch, Model 1	24,800	550
IBM 1403 Printer, Model 1	30,300	725
Total	$125,600	$2,475

Additional Equipment		
IBM 729 II Magnetic Tape Unit	$ 27,500	$ 700
IBM 729 IV Magnetic Tape Unit (Maximum of 6 tape units)	59,000	1,100
Tape Input-Output Adapter Feature	22,700	980
IBM 1406 (Additional Core) Storage (3 models)	20,100 to 55,100	575 to 1,575

Maintenance contracts available for purchased or rented equipment.

Hickok Mfg Co.

Rental configuration scheduled for installation:

Type	Model or Device	Description	Monthly Rental
1 1401	C03	Processing Unit	$2,680
1	560	Multiply-Divide Md 1 B C	325
1	617	Print Storage Md 1 B C D	375
1	497	High Low-Eq Comp B C D	75
1 1403	002	Printer ARR A	775
1 1402	002	Card Read Punch	550
5 729	002	Magnetic Tape Unit	770 ea

WE - Laureldale Plant

The Laureldale Plant presently employs conventional punch card equipment for mechanized data processing. A feasibility study has recently been completed and an IBM 1401 data processing system has been recommended. Management is currently considering this recommendation.

The recommended components of the 1401 are as follows:

Machine	Model	Description	Monthly Rental
1401	B4	Processing Unit (4,000 positions)	$ 1,630
	27	Advanced Programming-Index Registers	105
	321	Expanded Print Edit	20
	560	Multiply-Divide Device	325
	605	Additional Print Control	60
	611	Punch Feed Read	55
	497	High-Low-Equal Compare	75
	617	Print Storage	375
	627	Read Punch Release	25
	682	Sense Switches	15
1402	1	Card Read Punch	550
	619	Punch Feed Read	25
1403	2	Printer	775
1406	1	Storage (4,000 positions of Magnetic Core Storage)	575
		Total Monthly Rental	$4,610

Westinghouse

System components are IBM 1401-c3, IBM 1402, IBM 1403, IBM 1406, and IBM 729 II. The approximate monthly rental is $8,300.

Maintenance and service is provided by the manufacturer and is included in monthly rental.

PERSONNEL REQUIREMENTS

Manufacturer

Varies considerably according to installation and application.

Training made available by the manufacturer to the users includes programming and practical experience on systems.

Programming systems available are: symbolic programming system; generalized tape sorts; tape system utilities, including card-to-tape, tape-to-card, tape-to-printer; card report program generator; sub-routines; and debugging aids - service routines.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Reliability is achieved by utilizing solid state devices, i.e. core storage, printed circuits, and transistorized circuits. Checking, as previously detailed, also provides reliability.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features are: high speed card input-output, high speed magnetic tape input-output, high speed on-line printing, completely variable length core storage assignments, "Add-to-Storage" simplifies programming, and single-instruction print editing.

Unique system advantages are: solid-state engineering, economical, independent data processing system, auxiliary system to 700/7000 series, and simplified programming.

Growth of the system is permissible in the basic card system, the advanced card system, and the card and magnetic system.

Optional features as required, are available.

INSTALLATIONS

Boston Naval Shipyard
Boston, Massachusetts

General Electric Company, Inc.
Missile and Space Vehicle Department
3198 Chestnut Street
Philadelphia 4, Pennsylvania

General Insurance Company of America
4347 Brooklyn Avenue
Seattle 5, Washington

Hickok Manufacturing Company, Inc.
850 St. Paul Street
Rochester 1, N. Y.

Western Electric Company, Inc. - Laureldale Plant
Marion and Vine Streets
Laureldale, Pennsylvania

Westinghouse Electric Corporation, Steam Division
Lester Branch P. O.
Philadelphia 13, Pennsylvania

U. S. Army, Headquarters, TAGO
Washington 25, D. C.

U. S. Army Corps of Engineers
Engineer Maintenance Center
52 Starling Street
Columbus 16, Ohio (Proposed)

U. S. Army Quartermaster Depot
Richmond, Virginia (Proposed)

U. S. Army Signal Supply Agency
225 S. 18th Street
Philadelphia, Pennsylvania

U. S. Navy Administrative Office
EXOS, AO, EAD, EDPB
Washington 25, D. C. (Proposed)

U. S. Navy Bureau of Yards and Docks
Washington 25, D. C. (Proposed)

U. S. Navy Mare Island Shipyard
Vallejo, California

U. S. Naval Ordnance Laboratory
White Oak
Silver Spring, Maryland

U. S. Navy Ships Parts Control Center
Mechanicsburg, Pennsylvania

U. S. Air Force Air Defense Command
Ent Air Force Base
Colorado Springs, Colorado (Proposed)

U. S. Air Force Aviation Supply Office
700 Robbins Avenue
Philadelphia 11, Pennsylvania

U. S. Air Force Mathematical Services Laboratory
Eglin Air Force Base, Florida

U. S. Air Force Mobile Air Materiel Area
Brookley Air Force Base, Alabama

U. S. Air Force San Bernardino Air Materiel Area
Norton Air Force Base, California

Wright Air Development Center, ARDC
Directorate of Systems Engineering
Wright Patterson Air Force Base, Ohio (Proposed)

Air Weather Service
Climatic Center
225 D Street, S.E.
Washington 25, D. C. (Proposed)

U. S. Department of Agriculture (5)
Commodity Stabilization Service
New Orleans, Louisiana

Bureau of Flight Standards
Federal Aviation Agency
Oklahoma City, Oklahoma

Department of Health, Education & Welfare
Social Security Administration
Candler Building
Baltimore 2, Maryland (Proposed)

National Aeronautics and Space Administration
Lewis Research Center
Cleveland 35, Ohio

Tennessee Valley Authority
116 Old Post Office
Chattanooga, Tennessee

U. S. Treasury Department
Internal Revenue Service
10th - Constitution Avenues
Washington, D. C.

Veterans Administration
Data Processing Center
Hines, Illinois (Proposed)

American Telephone & Telegraph Company
Mount Kisco, New York (Proposed)

American Telephone & Telegraph Company (4)
50 Varick Street
New York, N. Y. (Proposed)

AVCO Corporation
Crosley Division
1329 Arlington Street
Cincinnati 29, Ohio (Proposed)

Bank of America (4)
500 Howard Street
San Francisco, California

Bankers Life Insurance Company of Nebraska
Cotner at O Street
Lincoln, Nebraska

Bell Telephone Laboratories (3)
Murray Hill, New Jersey (Proposed)

Bell Telephone Laboratories (3)
Whippany Road
Whippany, New Jersey (Proposed)

California Institute of Technology
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena 3, California

Chase Manhattan Bank
57 William Street, Room 200
New York, N. Y.

Combustion Engineering, Inc.
200 Madison Avenue
New York 16, N. Y.
(Installation Newark, New Jersey)

Consolidated Edison Company of New York
4 Irving Place
New York 3, N. Y.

Convair (2)
Fort Worth, Texas (Proposed)

Eastman Kodak Company (2)
Rochester, New York

El Paso Natural Gas Company (2)
P. O. Box 1492
El Paso, Texas

Esso Standard (2)
Humble Oil & Refining Company
P. O. Box 551
Baton Rouge, Louisiana

Firestone Tire & Rubber Company (2)
Akron 17, Ohio

Ford Motor Company
Dearborn Stamping Plant, Box 494
Controller's Office
Dearborn, Michigan (Proposed)

Ford Motor Company (2)
Ford Division
Rotunda and Southfield
Dearborn, Michigan (Proposed)

Ford Motor Company (2)
Manufacturing Services
Rouge Office Building
Dearborn, Michigan (Proposed)

General Motors Corporation (2)
A. C. Spark Plug Division
1300 N. Dort Highway
Flint, Michigan (Proposed)

General Motors Corporation
Allison Division
Indianapolis 6, Indiana

General Motors Corporation
Research Laboratories
12 Mile and Mound Roads
Warren, Michigan

Gulf Research & Development Company
P. O. Drawer 2038
Pittsburgh 30, Pennsylvania (Proposed)

Hughes Aircraft Company
5405 West 102nd Street
Los Angeles, California (Proposed)

International Business Machines Corporation
Scientific Computations Laboratory
Endicott, New York

International Business Machines Corporation
Data Systems Division
Poughkeepsie, New York

International Business Machines Corporation
Methods DS Manufacturing
South Road
Poughkeepsie, New York

International Harvester Company
1301 West 22nd Street
Broadview, Illinois (Proposed)

International Harvester Company
Motor Truck Division, Box 1109
Meyer Road
Fort Wayne, Indiana

The Marquardt Corporation
16555 Saticoy Street
Van Nuys, California

The Martin Company
Baltimore, Maryland (Proposed)

The Martin Company
Denver, Colorado

Minnesota Mining & Manufacturing Company (3)
900 Bush Avenue
St Paul 6, Minnesota

Newport News Ship and Drydock Company
Washington Avenue
Newport News, Virginia (Proposed)

The Ohio Oil Company (2)
539 South Main Street
Findlay, Ohio

Pratt and Whitney (2)
Florida Research & Development Center
United, Florida

Republic Aviation Corporation
Farmingdale, L. I., New York

Sandia Corporation (2)
Albuquerque, New Mexico (Proposed)

Service Bureau Corporation
IBM Plant
San Jose, California

Socony Mobil Oil Company, Inc.
150 E. 42nd Street
New York 17, N. Y.

Standard Oil Company of California
Electronic Computing Center
225 Bush Street
San Francisco 20, California (Proposed)

Standard Oil Company of Indiana
EDP Department
2400 New York Avenue
Whiting, Indiana

Standard Oil Company of Ohio (3)
717 Republic Building
Cleveland 15, Ohio

Texaco, Incorporated (11)
P. O. Box 2332
Houston 1, Texas

Western Electric Company (3)
77 South Wacker Drive
Chicago 23, Illinois (Proposed)

Western Electric Company (3)
100 Central Avenue
Kearny, New Jersey

Westinghouse Electric Corporation
Sharpsville Avenue
Sharon, Pennsylvania (Proposed)

Johns Hopkins University
Johns Hopkins Road
Scaggsville, Maryland

Midwestern Universities Research Association
2203 University Avenue
Madison 5, Wisconsin

Yale University
Computing Center
135 Prospect Street
New Haven, Connecticut

REMARKS

General Motors Allison Division

The 1401-1 is scheduled for shipment. The present specifications and prices are as follows:

Qty	Unit		Monthly Rental
1	1401 C-3		$3,385.03
	This price includes:		
	Advanced programming	$105	
	Column Binary	100	
	High-Low-Equal Compare	75	
	Print Storage	375	
1	1402		558.25
1	1403-2		786.63
	Printing Arrangement F		
2	729 II		at 710.50

The 1401-2 is also scheduled for shipment. The present specifications and prices are the same as the 1401-1 above with the exception of 1 729 II.

The 1401-3 is scheduled for shipment in May 1961. The present specifications and prices are as follows:

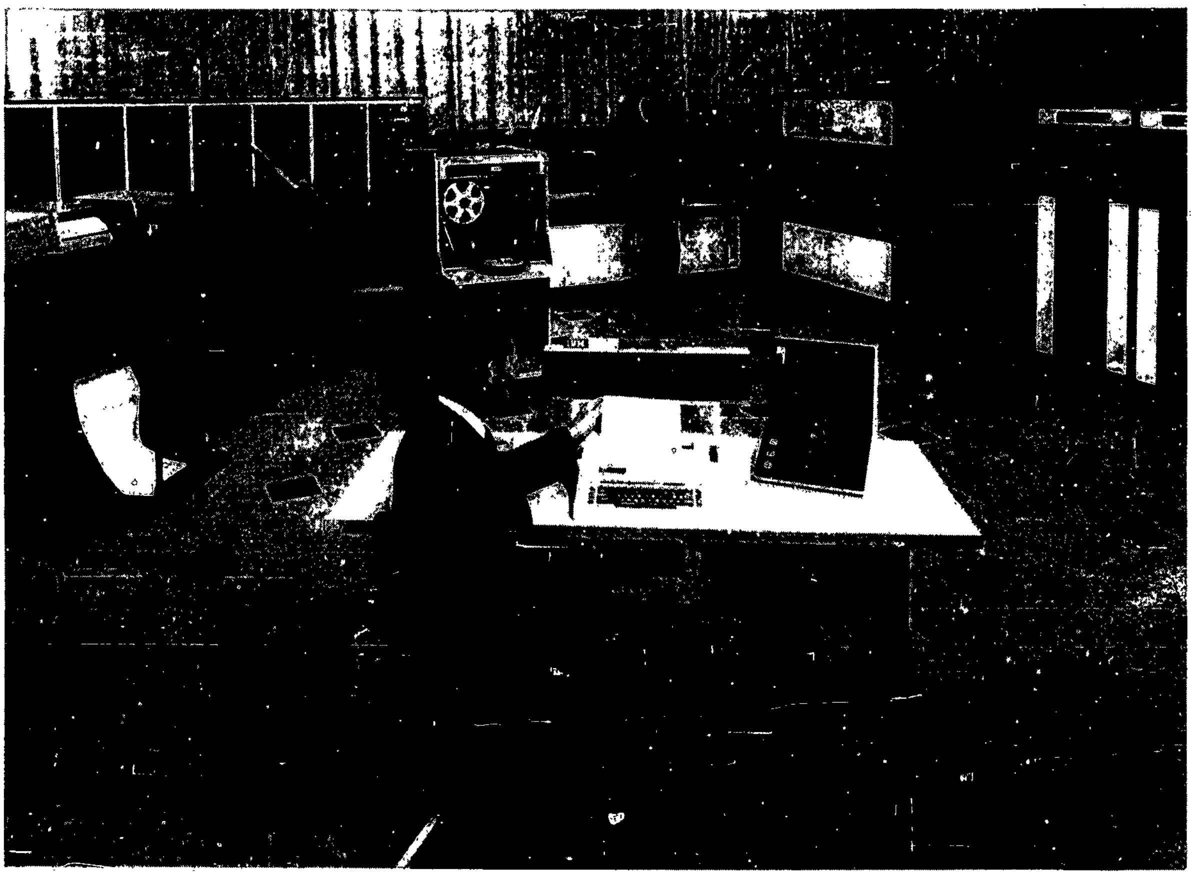
Qty	Unit		Monthly Rental
1	1401 C-4		$3,801.18
	This price includes:		
	Advanced programming	$105	
	Column Binary	100	
	High-Low-Equal Compare	75	
	Print Storage	375	
	Multiply Divide	325	
	Back Space File RPQ	40	
1	1402		558.25
1	1403		786.63
	Printing Arrangement F		
1	1406		583.63
1	729 II		710.50

IBM 1410

IBM 1410 Data Processing System

MANUFACTURER

International Business Machines Corporation



The new IBM 1410 greatly extends the range of intermediate computers for commercial data processing. Together, the 1410 and the 1401 system form a compatible machine family. Transition from a 1401 to a 1410 is possible with a minimum of system development costs.

Shown here is an expanded RAMAC 1410 system. The 1410 comes in card, magnetic tape, RAMAC and RAMAC tape models. With five RAMAC disk storage units, the 1410 can store 100-million characters of information for in-line processing.

Operator is seated at the 1415 console. From left to right in background are the 1403 printer, the 1402 card read punch, the 1411 processing unit and the 1011 paper tape reader. The girl is standing in front of the 1412 magnetic character reader used with the 1410 in banking applications. To her right are a 1405 disk storage unit, a 7330 low-cost magnetic tape unit and two 729 magnetic tape units. The 1410 can handle a total of twenty tape units.

APPLICATIONS

Portions of this description have been reprinted by permission from IBM General Information Manual 1410 Data Processing System, Copyright 1960 by International Business Machines Corporation.

Large volume commercial data processing and rapid scientific computations. System is available in a variety of configurations. The three basic configurations are the IBM 1410 Card System, the IBM 1410 Tape System and the IBM RAMAC 1410 System.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	Variable
Decimal digits/instruction	1 to 12
Instruction word format	

Op Code	A-or I-address	B-address	d-character
X	XXXXX (X-control field) XXX	XXXXX	X

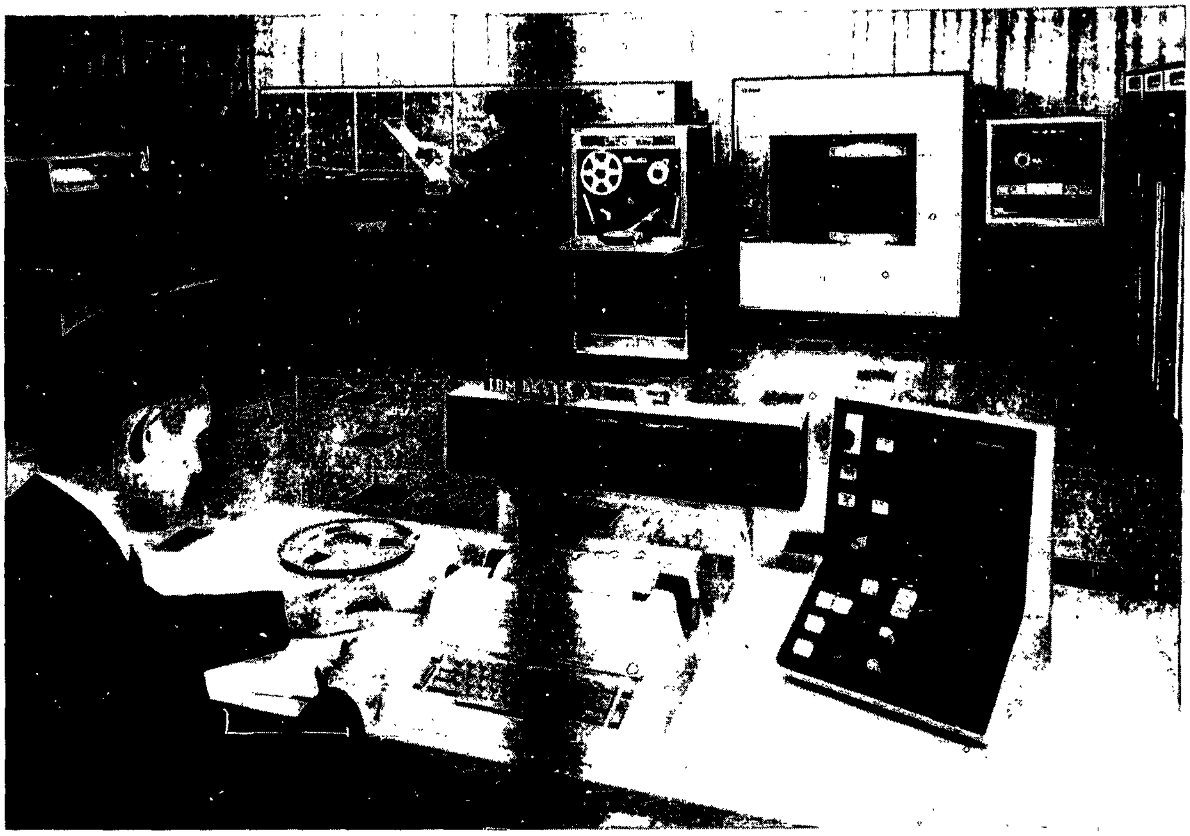


Photo by International Business Machines Corporation

Operations which may be performed are addressing operations, program control operations, arithmetic operations, logic operations, indexing, general data operations, input-output operations and checking operations.

To read out an address from storage, a device is needed to accept the address characters and keep them until the complete address has been read out. The devices used to do this are the address registers.

Instruction Address Register. The Instruction Address Register is a 5-character register. The address read into it specifies the initial address of an instruction in core storage.

A-Address Register. This register accepts a 5-character address that specifies the storage location of the first A-field character involved in the operation.

B-Address Register. This register accepts a 5-character address that specifies the storage location of the first B-field character involved in the operation.

Op Register. The Op-register (operation) is a 1-character register that stores the operation code of the instruction in process.

I/O Channel Select Register, Unit Select Register, and Unit Number Register. These registers accept the hundreds, tens, and unit positions of the X-control field that designates an I/O device. The hundreds position specifies the data transmission channel. The tens position specifies the I/O device. The units position specifies the number of that device such as tape drive 2.

There are 15 Indexing Registers of 5 characters each.

The 1410 uses stored-program instructions to cause input and output devices to operate. These instructions perform all the tape, RAMAC, arithmetic, logical, general data, and miscellaneous operations. The actual operation to be performed is indicated by the format and contents of the instruction itself.

The basic instruction format for the 1410 is divided into 4 parts - the operation code, the A-or I-address (5-characters), the B-address (5-characters), and a d-character modifier to the operation code. Because of the variable length instruction format, the length of a valid instruction can vary from 1 to 12 characters. An instruction word may also have an X-control field (3-characters) which designates an input-output device.

Programming aids include basic autocoder, advanced autocoder, with Macro instructions and an input/output package, FORTRAN, report generator, tape sorts, RAMAC sorts, utility programs, and COBOL.

ARITHMETIC UNIT

Add to storage system of logic is used to perform these operations.

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Media	No. of Characters	Access Microsec
Magnetic Core	40,000	4.5/char
Magnetic Disc (1405)	10,000,000(Model 1)	100,000 min
	20,000,000(Model 2)	800,000 max

Up to 5 disc units may be connected to the system. Thus, 5 Model 2 RAMAC units will have a capacity of 100,000,000 digits.

Magnetic Tape 729 (II and IV)

No. of units that can be connected	10 Units
No. of char/linear inch	200 or 556 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 or 112.5 Inches/sec
Transfer rate	15,000; 22,500; 41,667; 62,500 Chars/sec
Start time	10.8 or 7.3 Millisec
Stop time	10.8 or 7.3 Millisec
Average time for experienced operator to change reel of tape	30 - 60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Mylar

Mylar is DuPont's registered trade mark for Polyester Film.

IBM Magnetic Tape Unit 7330 operates at less speed and cost than the 729 Units. Both units utilize the two gap head and dual level sensing. Thus, a parity error is detected when the character is written.

Characteristics of the disc files are 10 or 20 million alpha-numeric characters per file, up to five files - 100,000,000 characters, up to 3 arms per file-maximum of 12 arms to a system, 200 characters per record, average access time - 500 ms. - 600 ms., one instruction to read a full track - 1,000 characters, and read and write overlapped with processing if overlap device is on Channel 1.

INPUT

Media	Speed
Cards (1402-2 Read/punch)	800 cards/min
Magnetic Tape	
729 II	15,000 or 41,000 char/sec
729 IV	22,500 or 62,500 char/sec
7330	7,200 or 20,000 char/sec
Paper Tape	500 char/sec

OUTPUT

Media	Speed
Cards (1402-2 Read/punch)	250 cards/min
Printer (1403)	600 lines/min
Magnetic Tape	As above

System utilizes an IBM 1414 Input-Output synchronizer, allowing CPU to compute while an input-output device is operating. Card units are completely buffered and checked. Printer operates at 75 inches/second, 100 or 132 char/line, with high speed carriage skipping. Magnetic tape units have optional overlap and dual gap heads for write checking.

The characteristics of the input-output synchronizers are:

The 1414-I has controls for 729 Tape Units and can attach 10 tapes to 1414-I.

The 1414-II has controls for 7330 Tape Units and can attach 10 tapes to 1414-II.

The 1414-III has controls for 1402 Card Read/punch and 1403 Printer, can attach 1-1402 and 1-1403, and has controls and buffers for other devices, e.g. paper tape input at 500 char/sec, which uses 5, 6, 7, or 8 channel tape.

System can have a maximum of three 1414's, one 1414-III, and two 1414-II's or I's, thus a maximum of 20 tapes is possible.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

System is composed of solid state, printed circuit, modular-cube components.

CHECKING FEATURES

Special checking features in the IBM 1410 Data Processing System assure reliability and accuracy of results. Checks must be made on the validity of data handled by the input-output units and one the handling of data within the system itself. Some of the checks include: legitimate instruction codes, arithmetic overflows, valid signs of numerical quantities, and many others.

In many cases, it is not necessary to interrupt machine operation when an error condition is detected. The programmer can insert branch instructions to recognize certain types of errors as exceptions. An error in reading a record from tape, for example, can be programmed to backspace the tape and re-read the record. If a correct reading is obtained the second time, normal operation continues. If the error persists, operation can be interrupted, or the incorrect record can be noted and operation continued.

Some machine check indicators, however, stop all processing immediately. They indicate such conditions as: a blown fuse, a broken tape, and card jams.

Three internal self-checking features incorporated into that 1410 system are parity, validity, and hole count.

Parity Checking

The 1410 uses an odd-bit parity system of recording binary-coded-decimal information. Each character is checked at various locations in the system to be sure that it has an odd number of bits.

If a parity error occurs, a console light is turned on to indicate the error location.

Validity Checking

If an invalid combination of punches enters the system through the card reader, the validity-check circuits detect it and turn on the read-check light on the card reader.

Hole-Count Checking

To provide additional reliability of data that are read or punched, the system employs a hole-count check feature. To perform hole-count checking, the system keeps an internal count of the total number of holes read from each column at the read-check station. The system compares this number against another count of the total number of holes read from the same column of the same card, when it passes the read station. Hole-count checking is also performed during punching operations. The count of the total number of holes to be punched in each column is retained internally for one punch-feed cycle. Another column-

by-column hole count is taken when this same card passes the punch-check station, and the two counts are compared.

If a hole-count error (unequal comparison of hole-count totals) occurs in the reader or punch, the system indicates the unit in error.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Unit	Dimensions (Inches) Width	Depth	Height	Weight (Lbs) (Maximum)	Service Clearance (Inches) Sides	Front and Rear	KVA
1402 Model 2	58	30 5/8	45	1,400	36	36	
1403	47 3/4	29	53 1/4	750	30	36	
1405	61	30	70	2,090	48	30	5.3
1411	146	31	70	2,800	2	43	14.0
1414 Models 1, 2, 3	38	31	70	600	2	43	
1414 Model 4	74	31	70	1,200	2	43	
1415	70	29	44	300	-	-	
729 II, IV	29 1/8	33 7/8	69 1/4	1,200	2	30	1.5
7330	29	31	58	500	2	30	1.0
Compressor	40	33	29	700	30	30	4.0

System requires 208V or 230V (±10%), 3 phase, 60 cycle.

Arrangement of units of the 1410 depends largely on the size and shape of the machine area, the system configuration, and the cable lengths available. Other factors to consider are customer-engineering service space, operator convenience, and visibility of units from a central operating position. Where space is limited, service clearance of adjacent units may overlap.

Storage and file area for cards, forms, and magnetic tape should be located conveniently in or near the machine room. Space near the 1410 is also required for customer-engineering test and maintenance equipment.

The 1410 system does not require raised flooring. However, a raised floor reduces the possibility of damage to cables, and presents a more attractive appearance of the installation.

Air conditioning equipment must maintain the machine-room area within certain limits of temperature and humidity:

Temperature 60 - 90°F.
Relative humidity 20 - 80%
Air Filtration 20% minimum (by National Bureau of Standards discoloration test)

These limits can be extended to 50-110°F. and 0-80% R. H. during non-operational periods. Low temperature and high humidity may cause moisture condensation. High temperatures deteriorate solid-state components.

If IBM cards and magnetic tape are not stored in the machine room, the storage area should be maintained at 50-90°F. and 30-65% R. H. for IBM cards, and 40-120°F. and 0-80% R. H. for magnetic tape. Recording instruments are recommended to provide a continuous record of temperature and humidity conditions in both the machine room and storage area.

Normal room air conditioning is usually adequate to accommodate the added heat generated. The table shows the approximate heat dissipation and air-flow for units of the 1410 system.

Unit	BTU/hr	CFM
1402 Model 2	5,600	390
1403	2,600	310
1405 (first unit)	7,240	800
each additional 1405	4,400	600
1411	18,000	2,000
1414 Model 1	2,130	500
Model 2	1,825	500
Model 3	2,560	500
Model 4	5,560	1,000
1415	940	--
729 II	4,310	350
IV	3,520	350
7330	2,400	400
Compressor	10,800	300

COST, PRICE AND RENTAL RATES

Basic System	
Central Processing Unit	1411
Card Read-Punch	1402-2
High Speed Printer	
Console	1415
Additional Equipment	
Magnetic Tape	729 II
Magnetic Tape	729 IV
Magnetic Tape	7330
Disc Storage	1405
Input-Output Synchronizer	1414-1-2-3-4

ADDITIONAL FEATURES AND REMARKS

Add to memory type instructions
 Add two fields and store result in one instruction
 No limit on size of result
Table look-up on high-low-equal or any combination
Edit, and expanded edit, are standard
Multiply and divide are standard
Any instruction can be indexed
 Fifteen 5-position index registers
 Increment or decrement
Move entire record or any part with one instruction
Additional logical instructions
 High-low-equal compare
 Zero balance test
 Overflow test
 Test digit or character
Store address register instructions

INSTALLATIONS

International Business Machines Corporation
590 Madison Avenue
New York, N. Y.

IBM 1620
IBM 1620 Data Processing System

MANUFACTURER
International Business Machines Corporation

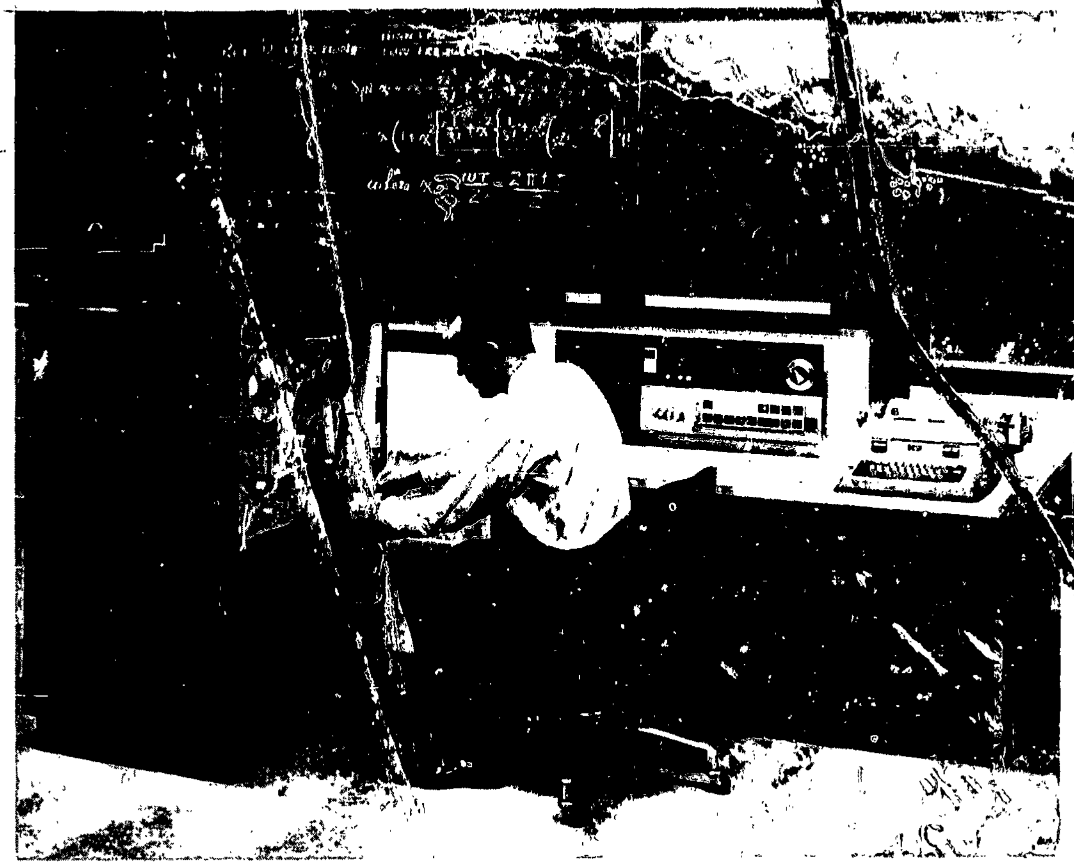


Photo by International Business Machines Corporation

Engineer adjusts paper tape which feeds data to IBM 1620 Data Processing System at the rate of 150 characters a second. The IBM 1620 is a compact, all-transistorized computer which handles the complicated formulas encountered in solving engineering and scientific problems in industry. Additions and subtractions are performed by the 1620 at the rate of more than 1700 a second for five-digit numbers. The use of conventional decimal arithmetic and simplified programming techniques, large-capacity core memory, and high-speed operation are among features of the new computer. A general purpose computer in the scientific area that features magnetic core storage.

APPLICATIONS

Manufacturer

System is used for the solution of problems in petroleum, public utilities, optics, general manufacturing, general engineering, civil engineering, and electronics.

American Machine & Foundry Co., Mechanics Research Div.
Located at 7501 North Natchez Avenue, Niles, Illinois, the system is used primarily for parachute design, thermodynamics (e.g. heat engines), structural design, soil loading, operations research, and servo system analysis.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal
Decimal digits/word	Variable field
Decimal digits/instruction	12
Instructions/word	Variable field 1 per 12 digits
Instructions decoded	32
Arithmetic system	Fixed point

Variable field fixed point; programmed floating point (8.5 millisec/floating add).

Instruction type	Two address
Number range	Variable field

Instruction word format

1 2	3 7	8 12
Operation	P-Address	Q Address

Automatic coding includes Symbolic Programming System, ForTran, and Go Tran.
Indirect addressing plus immediate instructions are available instead of indexing. Immediate instructions are standard. Indirect addressing is optional at $25 monthly rental. Branch transmit instruction provides single instruction linkage to subroutines.

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec
Add	(10 digit) 960
Mult	(10 digit) 17,700
Div	16,800

The 1620 is a 2-address system and times given above include access time to the two operands and the storing of the result.
Divide time includes loading dividends.
Table look up arithmetic is used. Table is stored in main memory of magnetic cores.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	Variable Field	20,000-60,000	20

INPUT

Manufacturer

Media	Speed
Paper Tape	150 char/sec (8-channel)
Typewriter	Manual (Alphanumeric)
Cards	250 cards/min (Buffered)

OUTPUT

Manufacturer

Media	Speed
Paper Tape	15 char/sec (8-channel)
Typewriter	10 char/sec (Alphanumeric)
Cards	125 cards/min (Buffered)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Diodes/Quan		Diodes/Quan		Diodes/Quan	
GS	174	AES	48	AS	1
FS	342	JS	24	AU	26
AAS	498				
Transistors/Quan		**Transistors/Quan**		**Transistors/Quan**	
-	4	039	969	078	36
015	48	065	48	083	172
025	436	071	78	086	40
033	1,357				
Magnetic Cores/Quan				**Magnetic Cores/Quan**	
17	120,000			24	200
18	384				

CHECKING FEATURES

Parity check on input, output, and internal manipulations of data.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	2 Kw
Area, computer	22 sq ft
Weight, computer	1,210 lbs

Special air conditioning or site preparation are not required.

AMF

Installed in air conditioned building. No special modifications were made.

PRODUCTION RECORD

Time required for delivery 10 months

PERSONNEL REQUIREMENTS

AMF

One supervisor and one programmer for one 8-hour shift.
Operation tends toward open shop.
Methods of training includes group instruction in Fortran.

FUTURE PLANS

The following organizations are replacing their IBM 610 Systems with the IBM 1620 Systems:
U. S. Naval Propellant Plant, Crane, Indiana
U. S. Army Transportation Research Command, Mathematical Sciences Division, Fort Eustis, Virginia
Lockheed Electronics Company, Plainfield, New Jersey
University of Louisville, Computing Laboratory, Louisville 8, Kentucky

INSTALLATIONS

American Machine & Foundry Co., Mechanics Research Division, 7501 N. Natchez Avenue, Niles, Illinois
Institute of Technology, Air University, Wright-Patterson Air Force Base, Ohio

COST, PRICE AND RENTAL RATES

Manufacturer

Components	Model or Feature No.	Monthly Charge	Purchase Price	Monthly Maintenance Charge Based on Age of Machine in Months 0-36	37-72	73-108
1620 Central Processing Unit	1	$1,375	$64,000	$76.75	$78.50	$81.00
Automatic Divide	47	55	2,400	2.75	2.75	2.75
Indirect Addressing	493	25	1,150	1.50	1.50	1.50
1621 Paper Tape Reader	1	200	9,100	14.50	14.50	17.50
1622 Card Read Punch	1	625	30,000	51.00	68.25	94.00
1623 Core Storage						
(20,000 positions)	1	800	39,500	29.00	32.50	36.00
(40,000 positions)	2	1,275	62,400	35.75	39.50	45.25
961 Tape Punch (8-track)	1	25	1,400	4.75	5.25	6.75

Monthly charges and rental rate, plus taxes when applicable. (Note: In our opinion, the 1620 system, with the exception of the 961 Tape Punch, at the present time is considered not to be subject to Manufacturers' Federal Excise Tax.)
Monthly maintenance charge applies to first 176 hours of use. Each hour of use beyond the 176 is billable at the rate of 1/176th of the charge listed.
Purchase price plus charge to field install of $40.00 for Automatic Divide, $35.00 for Indirect Addressing.

IBM 7070

IBM 7070 Data Processing System

MANUFACTURER

International Business Machines Corporation
590 Madison Avenue
New York 22, New York

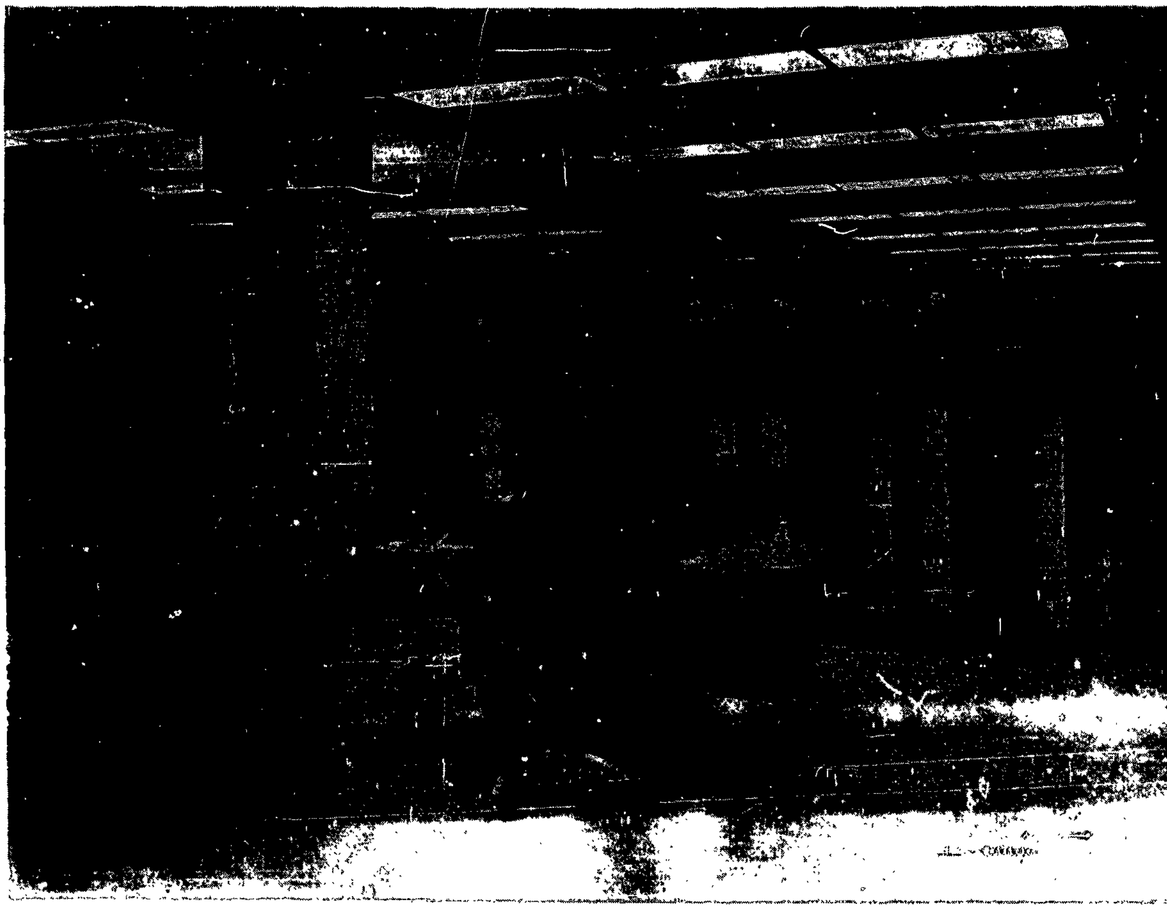


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer
System is used in the many areas of management decision criteria such as engineering design and development, research, accounting controls and reports, production, inventory controls and reports, and mathematical models.

U. S. Army Oversea Supply Agency
Located at the Brooklyn Army Terminal, Brooklyn 50, New York, the computer will be used to validate, edit, maintain supply status and render reports for requisitions received from Oversea Commands serviced by this Agency.

U.S.A.F. 1608th Air Transport Wing (MATS)
Located at the Statistical Services Division, Charleston Air Force Base, South Carolina, the system is used for the solution of problems in materiel, maintenance, personnel, accounting and finance, air operations, vehicle management, and civil engineering.

Union Carbide Chemicals Company
Located at the Union Carbide Chemical Company, Tech. Center, South Charleston, West Virginia, the system is used for engineering design calculations connected with building new plants and chemical processes, reduction and analysis of experimental data pertaining to research and development of new processes, and (future) business and data processing applications including cost accounting, inventory control and payroll.

Brown University
Located at the Division of Applied Mathematics, 180 George Street, Providence 6, R. I., the system is used for education in numerical analysis, data processing, and computer applications and for the conduct of research in computer applications in the physical, biological and social sciences, mathematics and linguistics.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Decimal 2 out of 5 fixed count code
Decimal digits/word	10 plus sign
Decimal digits/instruction	10 plus sign
Instructions per word	1
Instructions decoded	241
Arithmetic system	Fixed point Floating point (optional)
Instruction type	One address

Ability of addressing any part of a word

Number range
Fixed $-10^{10} < x < +10^{10}$
Floating $\pm 10^{-50} < x < \pm 10^{49}$

Instruction word format

Sign	Two Digit Operation Code	Two Digit Indexing Address	Field Control	Address of Data to be Processed
	X X	X X	X X	X X X X

Automatic built-in subroutines include interrupt system, edit commands, tape compression, table look-up, and record scatter-gather.

Automatic coding

Autocoder is a technique of programming which allows the 7070 to generate many machine instructions for one written operation; easily adaptable to commercial problems.

Fortran is a technique of programming in which the 7070 accepts problems written in formulae form; easily adaptable to scientific work.

Report generator is a generalized program permitting report preparation from any tape file containing the basic data required.

Input-output control system is a package which when included in a program automatically schedules simultaneous reading, writing and processing functions.

In addition to the above, utility routines, sort and merge programs and simulation routines are available for the 7070.

Registers

There are 99 words which may be designated as index words simplifying program preparation through automatic address modification and multiple use of single instructions. There are three addressable accumulators, an arithmetic register (intermediate storage) and an auxiliary register.

ARITHMETIC UNIT

Manufacturer

	Fixed Point Incl Stor Access Microsec	Digits
Add	72	(10+10)
Mult	672-1,488	(10x10)
Div	792-984	(1 to 5 in quotient)

Construction (Arithmetic unit only)

The arithmetic unit is constructed of transistors, diodes, and magnetic cores.

Arithmetic mode	Serial (adder)
Timing	Synchronous (Central Proc Unit) Asynchronous (Input-output Devices)
Operation	Sequential (Central Proc Unit) Concurrent (Input-output Devices)

The arithmetic unit is not an isolated unit.

Through a standard automatic priority processing feature, an input or output device can signal a 7070 stored program immediately on completion of an operation. On the basis of priority signals, a stored program can determine which steps to perform next to optimize utilization of all components.

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Microsec
Magnetic Core	5,000-9,990	50,000 to 99,900	6
Disc Storage	600,000 to 4,800,000	6 to 48 million	100-850 mil/sec

Disc storage access time is 100 to 850 milliseconds

Magnetic Tape

No. of units that can be connected	40 Units
No. of char/linear inch of tape	556 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating record	0.75 Inches
Tape speed	112.5 Inches/sec
Transfer rate	62.5K Char/sec
Start time	7.3 Millisec
Stop time	7.3 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	200-2,400 Feet
Composition	Mylar base

The above specifications reflect but one tape unit (729-4). There are other tape speeds attainable through another tape unit (729-2) with the tapes completely compatible. Mylar is DuPont's registered trademark for its polyester film.

USA OSA			
Core	10,000	100,000	6
USAF MATS			
Magnetic Core	5,000	50,000	6
Magnetic Disk	2,400,000	24,000,000	100-850 Millisec
UCC			
Magnetic Cores	5,000	50,000	6
Brown Univ			
Magnetic Core	5,000		
Magnetic Tape	4 units		

INPUT

Manufacturer

Media	Speed
Card Reader	500 cards/min
Magnetic Tape	15,000; 22,500; 41,600; 62,500 char/sec
Typewriter Remote Inq.	Manual
Console	Manual

USA OSA

Cards and 62,500 char/sec magnetic tape.

USAF MATS

Cards and 41,667 char/sec magnetic tape.

UCC

Cards

Brown Univ.

Cards, magnetic tape, and typewriter

OUTPUT

Manufacturer

Media	Speed
Card Punch	250 cards/min
Magnetic Tape	15,000; 22,500; 41,600; 62,500 char/sec
Printer	150 lines/min 120 alphanum char/line
Typewriter	600 char/min

Peripheral operations i.e. card to tape, tape to printer, and tape to card will in many cases replace card input, printer and card output and be done by the IBM 1401 Data Processing System. Speeds are as follows:

Card Read	800 cards/min
Printer	600 lines/min
Card Punch	250 cards/min

USA OSA

Tape	62,500 char/sec
Card	250 cards/min
Typewriter	10 char/sec

USAF MATS

Magnetic Tape	41,667 char/sec (729 II Tape Drive)
Punched Cards	250 cards/min

UCC

Cards	250 cards/min

Brown Univ.

Cards, printer, magnetic tape, and typewriter.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity	
Magnetic Cores	300,000	5,000 words memory
	600,000	10,000 words memory

CHECKING FEATURES

Manufacturer

The transfer of information between memory and the arithmetic and programming unit or input/output devices is completely checked for validity.

All input/output devices including card readers, card punches, tape units and printers are validity checked on transfer of information. For example, tape units have dual read/write heads which check writing validity at the time the record is created.

All arithmetic operations are checked.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	19.3 KVA
Weight, computer	23,150 lbs

It is suggested that the space requirements for the 7070 be extracted from actual installations, as this figure can vary widely. Physical planning manual available from manufacturer.

USA OSA

Power, computer	30 Kw	54 KVA	0.75 pf
Power, air cond	54 Kw	72 KVA	0.75 pf
Volume, computer	1,130 cu ft		
Volume, air conditioner	800 cu ft		
Area, computer	1,600 sq ft		
Area, air conditioner	800 sq ft		
Room size, computer	40 ft x 40 ft		
Room size, air condi	20 ft x 40 ft		
Floor loading	400 lbs/sq ft		
	2,800 lbs concen max		
Capacity, air condition	50 Tons (incl transceiver room)		

Weight, computer	41,000 lbs
Weight, air conditioner	15,000 lbs

Site preparation consisted of building modification, power installation, floating floors and air conditioning.

USAF MATS

Power, computer	39.8 KVA
Power, air conditioner	24 Kw

UCC

Power, computer	18.6 KVA
Area, computer	864 sq ft

Floating floor.

Brown Univ.

Computer is housed in a separate building, designed by Philip Johnson, Associates, for the purpose.

PRODUCTION RECORD

Manufacturer

Time required for delivery approx 12 months

COST, PRICE AND RENTAL RATES

Manufacturer

		Model	Monthly Rental	Purchase Price
729	Magnetic Tape Unit	2	$ 700	$ 27,500
		4	900	48,500
7150	Console Cntrl Unit	1	300	13,050
7300	Disk Storage	1	975	62,200
		2	1,500	74,800
7301	Core Storage	1	3,500	160,000
		2	6,800	285,400
7400	Printer	1	950	41,500
7500	Card Reader	1	400	18,000
7501	Console Card Reader	1	75	3,700
7550	Card Punch	1	550	24,600
7600	Input-Output Control	1	1,400	63,000
		2	800	33,000
7601	Arith & Prog Cntrl	1	3,000	138,100
7602	Core Storage Control	1	1,400	65,200
		2	1,600	73,950
		3	1,500	69,800
		4	1,800	83,800
		5	1,900	88,500
7603	Input-Output Synch	1	1,000	46,050
		2	1,300	59,250
		3	1,350	62,050
		4	1,650	75,250
		5	2,000	91,250
		6	1,700	78,050
		7	1,600	72,450
		8	1,950	88,450
		9	2,300	104,450
7604	Tape Control	1	2,700	122,550
		2	1,850	94,000
7605	Disk Storage Cntrl	1	3,900	174,000
7802	Power Converter	1	400	18,700
7900	Inquiry Station	1	250	10,300

Maintenance contract available

A sample 7070 installation rental is as follows:

Quantity	Machine Type		Monthly Rental
8	729-2	Tape Units	$5,600
1	7150	Console Control Unit	300
1	7301	Core Storage (5,000 words)	3,500
1	7501	Console Card Reader	75
1	7600	Input/output Control	825
1	7601	Arith, & Prog. Control	3,000
1	7602	Core Storage Control	1,600
1	7604	Tape Control (2 channel)	2,700
1	7802	Power Converter	400
			$18,000

This is a tape-oriented system. For card-tape, tape-card, tape-printer operations, a 1401 machine would be used. This equipment is described elsewhere in the writeups.

The above rental rates include customer engineering maintenance and parts and cover the first 176 hours a month the system is in use. Each hour of use thereafter is subject to a rate of 1/176 of 40%.

A maintenance contract is available for components of a purchased system at rates per a published schedule.

Purchase price, typical system: $813,250
Rental price, typical system: $ 17,400 monthly

USA OSA

Rental is $27,950/month.

1-727 Tape Drive, 1-720 II Printer, and 1-760 Printer Control, rents at a total of $4,950/month.

Maintenance included in rental.

USAF MATS

Quantity	Type	Monthly Rental
1	7150	$ 300
2	7300	3,000
1	7301	3,500
1	7500	400
1	7550	550
1	7600	1,400
1	7601	3,000
1	7602	1,900
1	7603	2,050
1	7604	2,700
1	7605	3,900
1	7802	400
1	7900	250
4	729	2,800
1	533	765
2	Typewriter	420
		$27,335

UCC

Basic 7070/card input/card output cost $580,000.

407 Printer, storage for panel boards, keypunch, and above system rental at $12,700/month.

The 407 rents at $850/month.

Brown Univ.

A 7070 System, with 4 tape drives, automatic floating point, on line printer and 407 tabulator is purchased.

Key punches, reproducer and sorter are rented.

Service contract with IBM for purchased system.

PERSONNEL REQUIREMENTS

Manufacturer

The number of people required will vary a great deal based upon type of work (scientific, commercial mix), type of industry coupled with application.

Education training, program testing, technical assistance on all phases is available.

USA OSA

	One 8-Hour Shift	
	Used	Recommended
Supervisors	4	4
Analysts	8	8
Programmers-Coders	12	16
Clerks	1	4

Methods of training used includes internal orientation, IBM programming school and on-the-job training.

USAF MATS

	One 8-Hour Shift	
	Used	Recommended
Supervisors	4	4
Analysts	8	8
Programmers-Coders	20	20
Librarians	1	1
Operators	1	1
Engineers	1	1
In-Output Oper	1	1
Tape Handlers	1	1

Methods of training used includes contractor schools and on-the-job training.

UCC

	One 8-Hour Shift
Supervisors	3
Analysts	2
Programmers	3
Operators	2

Operation tends toward closed shop.

Methods of training used is manufacturer's training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

System features and construction techniques utilized by manufacturer to insure required reliability include diagnostic programs and marginal checking, to detect and anticipate component failures, and solid state components together with conservative circuit design criteria, to assure a high level of reliability.

UCC

Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

One of the most outstanding features of the 7070 is its modularity. For growth, the 7070 System can be quickly and easily converted to the 7074 in the field. The 7074 is 6 to 20 times as fast as the 7070 internally, and completely compatible with programs written for the 7070. The 7070 can be used efficiently for a scientific-commercial mix.

USA OSA

Magnetic tape library on wheels will store input tapes in alternate area. This will allow for recreation of files as of yesterday. Normal IBM procedures are used for labelling and handling of magnetic tapes. Tape library procedures provide for central control or tape and program set up. Librarian will be focal point of operation.

USAF MATS

The Inventory Control Application will operate online from remote input/output stations simultaneously with other periodically processed applications.

Use will be made of the IBM Input/Output Control System (IOCS) for all tape operations. A fireproof vault has been built adjacent to the computer room for magnetic tape storage.

FUTURE PLANS

Manufacturer

See IBM 7074 Data Processing System.

USA OSA

A 1401-C System will replace the 727, 720 II and 760 in about 1 year.

Additional applications will include performing same functions for Mutual Security requirements.

USAF MATS

The system will be modified to provide improved printing capability, either through acquisition of an on-line printer or through acquisition of an IBM 1401 System.

UCC

Use of magnetic tape is planned for the system.

An IBM 7070 is anticipated at the U. S. Naval Ordnance Laboratory, Corona, California.

An IBM 7070 w/8 tapes is anticipated at the General Insurance Company of America.

An IBM 7070 is anticipated at the Western Electric Company.

INSTALLATIONS

U. S. Army Quartermaster Depot
Richmond, Virginia (Proposed)

U. S. Navy Puget Sound Shipyard
Bremerton, Washington (Proposed)

American Airlines
100 Park Avenue
New York, N. Y. (Proposed)

AVCO Corporation
Crosley Division
1329 Arlington Street
Cincinnati 29, Ohio (Proposed)

General Motors Corporation
A. C. Spark Plug Division
1300 N. Dort Highway
Flint, Michigan (Proposed)

The Martin Company
Baltimore, Maryland (Proposed)

Mutual Benefit Life Insurance Company
520 Broad Street
Newark 1, New Jersey (Proposed)

Western Electric Company
77 So. Wacker Drive
Chicago, Illinois (Proposed)

University of Rochester
Rochester, New York (Proposed)

U. S. Army Oversea Supply Agency, New York
Brooklyn Army Terminal
Brooklyn 50, New York

1608th Air Transport Wing (MATS)
Charleston Air Force Base, South Carolina

Union Carbide Chemicals Company
Technical Center
South Charleston, West Virginia

Brown University
Division of Applied Mathematics
Providence 12, Rhode Island

Indiana University
Research Computing Center
Bloomington, Indiana

Yale University
Computing Center
135 Prospect Street
New Haven, Connecticut

Bank of America (2)
500 Howard Street
San Francisco, California

Combustion Engineering, Inc.
200 Madison Avenue
New York 16, N. Y.
(Installation Newark, N. J.)

El Paso Natural Gas Company
P. O. Box 1492
El Paso, Texas

General Motors Corporation
A. C. Spark Plug Division
7929 S. Howell
Milwaukee 1, Wisconsin

The Ohio Oil Company
539 South Main Street
Findlay, Ohio

Universal Oil Products Company
30 Algonquin Road
Des Plaines, Illinois

U. S. Treasury Department (3)
Internal Revenue Service
10th Constitution Avenues
Washington, D. C.

IBM 7074

IBM 7074 Data Processing System

MANUFACTURER

International Business Machines Corporation

APPLICATIONS

For use in commercial and/or scientific applications. This system has the flexibility of componentry and internal speeds to allow for either type of application.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	2 out of 5 fixed-count coded decimal
Decimal digits/word	10 plus sign
Decimal digits/instruction	10 plus sign
Instructions decoded	241
Arithmetic system	Fixed point

Floating point is optional

Instruction type	One address (with ability of addressing any part of a word)

Number range

Fixed point $-10^{10} < x < +10^{10}$

Floating point $|\pm 10^{-50}| < x < |\pm 10^{49}|$

Instruction word format

Sign	2-Digit Op Code		2-Digit Index Address		Field Control		Address of Data			
	x	x	x	x	x	x	x	x	x	x

Automatic built-in subroutines include interrupt system, edit commands, tape compression, table lo k-up, and record scatter-gather.

Automatic coding: As on the IBM 7070 there is Autocoder, Fortran, Report Generator, and an Input/Output Control System.

There are 99 words which may be designated as index words.

There are three addressable accumulators, an arithmetic register (intermediate storage) and an auxiliary register.

ARITHMETIC UNIT

Operation Time	Fixed Point Incl Stor Access Microsec
Add	10
Mult	56 (0-9 by 0-9)
Div	70 (5 digits quotient)

Arithmetic mode	Serial
Timing	Synchronous
Operation	Concurrent in Input/Output

The arithmetic unit is not an isolated unit.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	5,000 or 9,990	50,000 or 99,900	4
Disk Storage	600,000 to 4,800,000	6 to 48 million	

Disc storage access time is 100 to 850 millisec.

Magnetic Tape

No. of units that can be connected	40 Units
No. of chars/linear inch of tape	556 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	112.5 Inches/sec
Transfer rate	62,500 Chars/sec
Start-stop time	7.3 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	200-2,400 Feet
Composition	Mylar base

DuPonts registered trademark for its polyester film. The above specifications reflect the IBM 729-IV tape drive. Also available is a 729-II tape drive. A density mode in both tape drives provides four different speed rates and complete interchangeability of data on both drives.

INPUT

Media	Speed
Card Reader	500 cards/min (Control Panel Format)
Magnetic Tape	15,000; 22,500; 41,600; 62,500 chars/sec
Typewriter Remote Inquiry	Manual
Console	Manual
Disk Storage	12,000 dig/sec

OUTPUT

Media	Speed
Card Punch	250 cards/min (Control Panel Format)
Magnetic Tape	Same as input
Printer	150 lines/min 120 char/line (Control Panel Format)
Typewriter	10 char/sec Format selection
Disk Storage	6 K D 6,000 dig/sec, includes write compare check

For tape-oriented systems (no card equipment on line) an IBM 1401 Data Processing System would be used for peripheral operations at speeds of: card read, 800 cards/min; card punch, 250 cards/min; and printer, 600 lines/min.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Magnetic Cores	300,000	5,000 words of memory
	600,000	10,000 words of memory

CHECKING FEATURES

The transfer of information between memory and the arithmetic and programming unit or input/output devices is completely checked for validity. All input/output devices including card readers, card punches, tape units and printers are validity checked on transfer of information. For example, tape units have dual read/write heads which check writing validity at the time the record is created.

All arithmetic operations are checked.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	29.14 KVA
Weight, computer	23,150 lbs

Physical planning manual and assistance available on request. It is suggested that space requirements for the 7074 be extracted from actual installations, as this figure can vary widely.

COST, PRICE AND RENTAL RATES

Machine	Model	Monthly Rental	Purchase Price
729 Magnetic Tape Unit	2	$ 700	$27,500
	4	900	48,500
7150 Console Control Unit	1	300	13,050
7300 Disk Storage	1	975	62,200
	2	1,500	74,800
7400 Printer	1	950	41,500
7500 Card Reader	1	400	18,000
7501 Console Card Reader	1	75	3,700
7550 Card Punch	1	550	24,600
7600 Input-Output Control	1	1,400	63,000
	2	800	33,000
7603 Input-Output Synchronizer	1	1,000	46,050
	2	1,300	59,250
	3	1,350	62,050
	4	1,650	75,250
	5	2,000	91,250
	6	1,700	78,050
	7	1,600	72,450
	8	1,950	88,450
	9	2,300	104,450
7604 Tape Control	1	2,700	122,550
	2	1,850	94,000
7605 Disk Storage Control	1	3,900	174,000
7802 Power Converter	1	400	18,700
7900 Inquiry Station	1	250	10,300
7104 High Speed Processor	1	7,300	313,000
	2	7,400	317,000
	3	7,500	321,000
	4	7,700	329,000
	5	7,800	333,000
7602 Core Storage Control	6	1,200	49,400
7301 Core Storage	3	4,700	208,600
	4	8,000	334,000

Selling Price, Average System	$1,284,350
Monthly Rental, Average System	29,300

Maintenance contract available on request.

PERSONNEL REQUIREMENTS

Number of people required varies according to volume of work and type of applications.

Training made available by the manufacturer to the users includes education, training, program testing, and technical assistance in all phases.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Diagnostic programs and marginal checking are used to detect and anticipate component failures.

Solid-state components, together with conservative circuit design criteria assure a high level of reliability.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include conversion from the IBM 7070 to the IBM 7074 which may take place in the field. (See IBM 7070). The 7074 is completely compatible with 7070 programs. Thus a customer is able to obtain additional processing power to match job growth with minimum effort and expense.

Sales Engineers and texts will be available to assist installations in the area of magnetic tape handling.

IBM 7080

IBM 7080 Data Processing System

MANUFACTURER

International Business Machines Corporation

Photo by International Business Machines Corporation

APPLICATIONS

This is a general purpose computer designed for both commercial and scientific applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Alphabetic
Alphanumeric chars/word	Variable
Alphanumeric chars/instruction	5
Instructions decoded	69
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-10^{255} < M < 10^{255}$

Instruction word format

Operation	Address with zone bits as indicators

Automatic built-in subroutines includes an interrupt system, a store-for-print, and a transmit.

Automatic coding includes 7080 Processor including Auto coder III, File Maintenance and Report/File Writing, Decision Making and Fortran.

Registers includes one 256 character accumulator, 30 auxiliary storage units (512 characters), and 32 eight character words for communication storage.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add (6+6)	13.08	(6 char + 6 char)
Mult (6x6)	140	(6 char x 6 char)
Div	210	(10 char/6 char)

Construction (Arithmetic unit only)

Transistors	36,000
Magnetic Cores	9,000

Arithmetic mode	Serial
Timing	Synchronous and Asynchronous
Operation	Concurrent

STORAGE

Media	No. of Characters	Access Microsec
Core	40,000; 80,000; 160,000	2.18
Core (Fast Registers)		1.09

Magnetic Tape

No. of units that can be connected	50	Units
No. of chars/linear inch	200 or 556	Chars/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating each record	0.75	Inches
Tape speed	75 or 112.5	Inches/sec
Transfer rate	15,000; 22,500; 41,667; 62,500	Chars/sec
Start-stop time	10.8 or 7.3	Millisec
Average time for experienced operator to change reel of tape	60	Seconds
Physical properties of tape		
Width	0.5	Inches
Length of reel	2,400	Feet

INPUT

Media	Speed
Magnetic Tape	See Storage
Card	250 cards/min

OUTPUT

Media	Speed
Magnetic Tape	See Storage
Card	100 cards/min
Console Typewriter	600 char/min

In addition to the above components, an IBM 1401 Data Processing System may be used for peripheral operations. The speeds of the 1401 components are:

Card Reading	800 cards/min
Card Punching	250 cards/min
Printing	600 lines/min
Tapes	The 7080 tapes are completely compatible with the 1401 system

CHECKING FEATURES

Character code check on internal operations and data transmission sign check for arithmetic instructions overflow, character code check during transmission from storage to I/O units, horizontal and vertical parity check on magnetic tape, dual level sensing, two gap head for verification of tape writing, two read stations in card reader, echo checking on line printer, and row-count comparison in card punching.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	14.4 Kw
Area, computer	1,000-1,200 sq ft (approx)
Floor loading	100 lbs/sq ft
Weight, computer	19,700 lbs

Site preparation requirements: Physical planning manual and assistance available.

PRODUCTION RECORD

Time required for delivery 12 months

COST, PRICE AND RENTAL RATES

Type	Description	Model	Monthly Rental	Purchase Price
7102	Arith & Logical Unit	1	$14,500	$685,000
7153	Console Control Unit	1	1,500	75,000
7302	Core Storage	1	17,500	840,000
7305	Ctrl Stor & I/O Ctrl	1	7,300	345,000
		2	8,400	395,000
7800	Power Converter	1	700	25,000
7801	Power Control	1	900	35,000
7621	Tape Control	2	3,300	147,000
729	Magnetic Tape Unit	2	700	27,000
729	Magnetic Tape Unit	4	900	48,500
7622	Signal Control	1	1,500	26.000

The above renatl rates include customer engineering maintenance and parts and cover the first 176 hours a month the system is in use. Each hour of use thereafter is subject to a rate of 1/176th of 40%.

A maintenance contract is available for components of a purchased system at rates per a published schedule.

Purchase Price, typical system: $2,200,000
Monthly Rental, typical system: $ 48,000

PERSONNEL REQUIREMENTS

The number of people required to operate this computer system will vary with the configuration, the application and the policies of the user.

Education and training in all phases of computer use are provided by the manufacturer. One week classes conducted for executives at IBM educational departments in Endicott and Poughkeepsie, New York. Comparable classes are available in several major cities across the country. These courses are designed to acquaint executives with the organization, operating characteristics, capacities, and applications of the 7080. Customers who complete this course are better able to evaluate the advantages, economics and wide business applications of the 7080. In addition to the executive class, courses are available to qualified methods personnel. These classes are of longer duration and provide knowledge of programming and necessary operating details. Special representatives offer overall consulting service in connection with the study of possible uses. Sales engineers are available to assist in preparing the site for physical installation. This assistance begins twelve months in advance of delivery. The Programming Service has personnel available for consultation with field representatives and customers. A library of programs common to many problems is available for adoption as sub-routines by customer. Automatic coding, as listed under automatic coding, is available. Symbolic coding methods and assembly programs are available.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

This system is completely compatible with the IBM 705 Data Processing System. The logic of these systems is carried forward with additional features to increase the memory size and the internal speed and usefulness of the data channels.

ADDITIONAL FEATURES AND REMARKS

Reference is made to the 7080 Physical Planning Manual which assists in the preparation of the site.

INSTALLATIONS

International Business Machines Corp., Data Systems Division, Poughkeepsie, N. Y.

International Business Machines Corp., Methods DS Manufacturing, South Road, Poughkeepsie, N. Y.

Eastman Kodak Company, Rochester, N. Y.

Commonwealth Edison Company, 72 W. Adams Street, Chicago, Ill.

International Harvester Co., Motor Truck Div., Box 1109, Meyer Road, Fort Wayne, Indiana

Convair, Fort Worth, Texas (Proposed)

IBM 7090

IBM 7090 Data Processing System

MANUFACTURER

International Business Machines Corporation

Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

System is designed and used for scientific and commercial data processing, real time flight control, safety and impact prediction calculations, and message processing.

General Electric-Missile & Space Vehicle Dept.

Located at 3198 Chestnut Street, Philadelphia 4, Pa., the system is used for flight test data reduction, for engineering computations, including aerodynamics, flight mechanics space science problems, for trajectory analysis, for data processing including recording, updating and maintaining files on provisioning, reliability, document control, weight and balance, and wiring harness problems, and business data processing routines such as personnel accounting records, cost ledger, general ledgers and budget exercises.

Space Technology Laboratories, Inc.

Located at El Segundo, California, the system is used for the full spectrum of scientific computations.

Union Carbide Corporation

Located on the 36th floor of the Union Carbide Building, 270 Park Avenue, New York City, the system is used for sales analysis, financial reporting, product costing, engineering studies, operations research and economic studies, scientific analysis, and others to be added as time goes by.

Westinghouse Electric Corporation, Steam Division

Located at Lester Branch P.O., Philadelphia 13, Pa., the system is used for commercial applications, e.g. integrated data processing system including payroll, personnel statirtics, labor distribution, inventory control, shop scheduling, shop simulation, manufacturing information, general and cost accounting, dispatch, purchasing, drafting planning, sales negotiation, linear programming, and statistical analyses, and for scientific applications, e.g. turbine performance, testing, and design, numerically controlled machine tools, stress analysis, heat balance, and

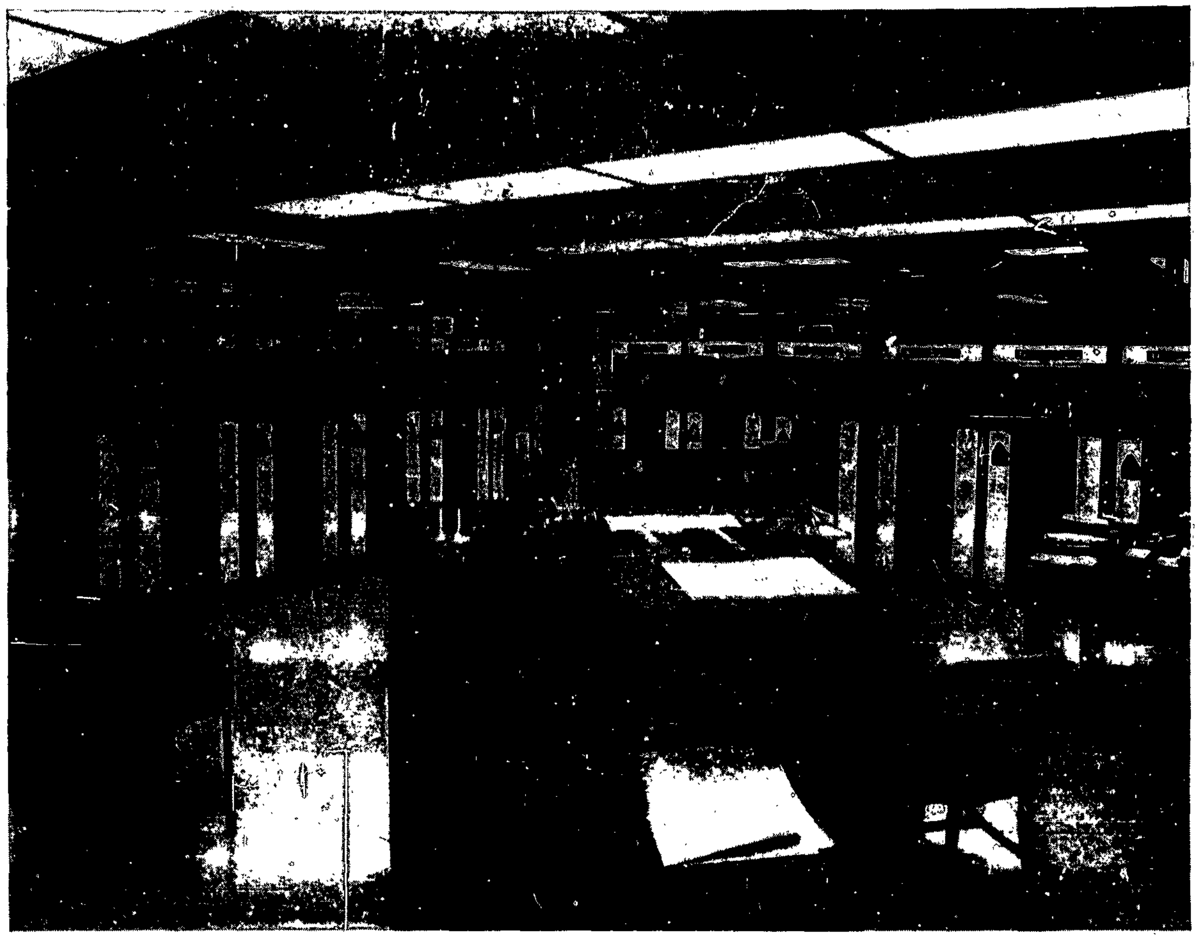


Photo by General Electric Company, Missile & Space Vehicle Department

curve fitting.

University of California Lawrence Radiation Laboratories

Located at Livermore, California, the system is used for the solution of differential equations.

Automatic coding includes the SHARE Operating System and FORTRAN.

There are three index registers and four arithmetic registers (full word), i.e. the Accumulator, Multiplier-Quotient, Storage and Sense Indicator registers.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary
Binary digits/word	36
Binary digits/instruction	36
Instructions/word	1
Instructions decoded	205
Arithmetic system	Fixed and floating point
Instruction type	One address
Number range	Floating $-10^{38} < N < 10^{38}$
	Fixed $-(2^{35}-1) \leq N \leq (2^{35}-1)$

Instruction word format

Op Code	Flag	Tag	Address
S 1 11	12 13	18 21	22 35

Format varies with instruction type

ARITHMETIC UNIT

Manufacturer

	Fixed Point Microsec	Floating Point Microsec
Add	4.36	13.08 to 32.70
Mult	4.36-30.52	4.36 - 28.34
Div	6.54-32.70	6.54 - 28.34

Construction (Arithmetic unit only)

The arithmetic unit is constructed of 20,000 transistors.

Arithmetic mode	Parallel
Timing	Synchronous (Central Proc Unit)
	Asynchronous (Input-Output)
Operation	Sequential (Central Proc Unit)
	Concurrent (Input-Output)

Input and output operations on up to eight data channels can operate concurrently with the main computational program in the Central Processing Unit.

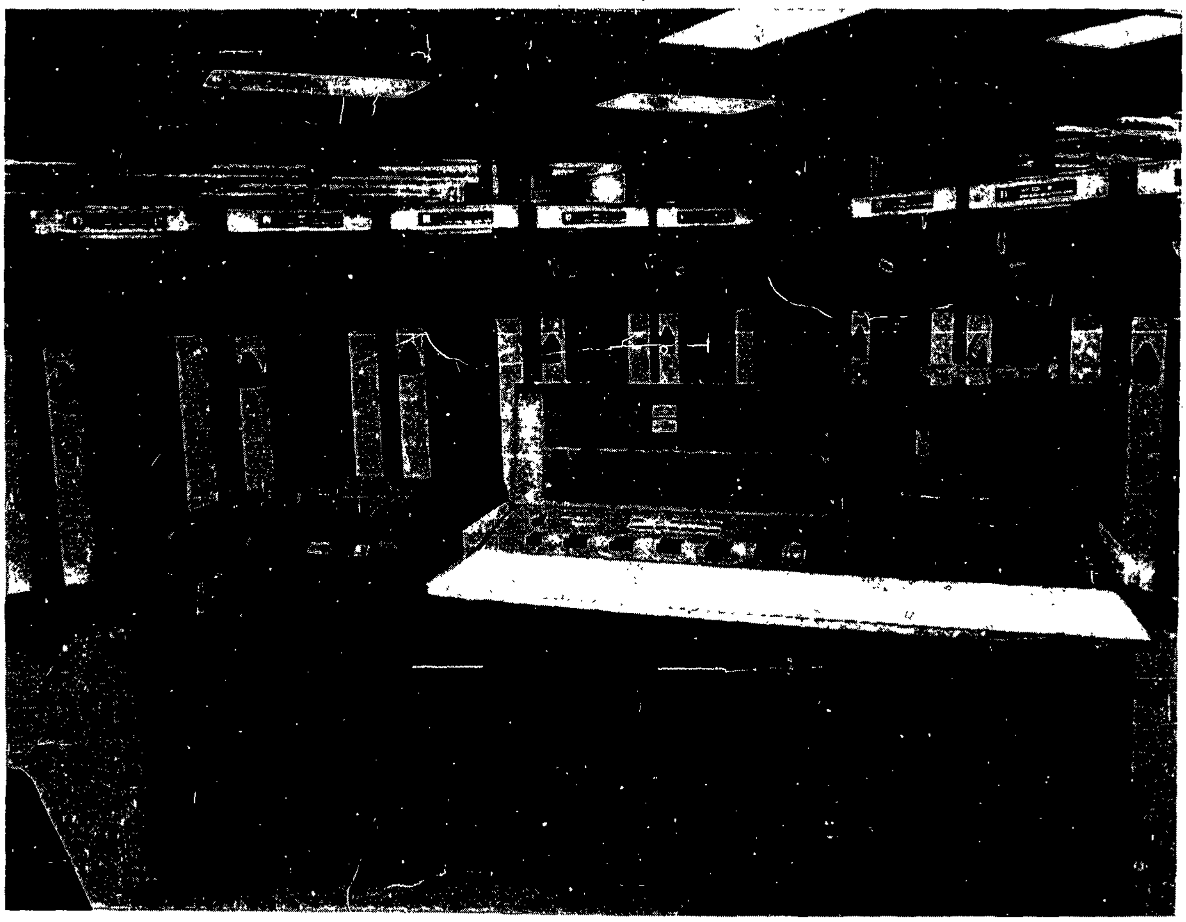


Photo by General Electric Company, Missile & Space Vehicle Department

STORAGE

Manufacturer

Media	No. of Words	Access Microsec
Magnetic Core	32,768	2.18
Magnetic Tape	2,500,000/reel	7,000 or 10,000

No. of units that can be connected 80 Units
No. of chars/linear inch 200 or 556 Chars/inch
Channels or tracks on the tape 7 Tracks/tape
Blank tape separating each record 0.75 Inches
Tape speed 75 or 112.5 Inches/sec
Transfer rate 15,000; 22,500; 41,667; 62,500 Chars/sec
Start time 10.8 or 7.3 Millisec
Stop time 10.8 or 7.3 Millisec
Average time for experienced operator to change reel of tape 30 - 60 Seconds
Physical properties of tape
Width 0.5 Inches
Length of reel 2,400 Feet
Composition Mylar
Mylar is DuPont's registered trade mark for Polyester Film.

GE
Magnetic core and 10 magnetic tape units.

Space Tech Labs
Magnetic core and magnetic tape.

Union Carbide
Magnetic core and magnetic tape.

Westinghouse
Magnetic core and magnetic tape.

UCLRL

Media	No. of Words	Access Microsec
Core	32,768	2
Magnetic Tapes 729 IV	6 Tape Units	970
Magnetic Tapes 729 II	4 Tape Units	1,400

The above indicated access time is for reading in low density mode. For writing, it would be 729 II 4400 microsec and 729 IV 2970 microsec. High density operation for 729 II 250 microsec faster and for 729 IV 170 microsec.

INPUT

Manufacturer

Media	Speed
Magnetic Tape	See Storage
Cards	250 cards/min (on-line)
Card to Magnetic Tape	250 or 800 cards/min (off-line)

Higher conversion rate using IBM 1401 for generating input tape.

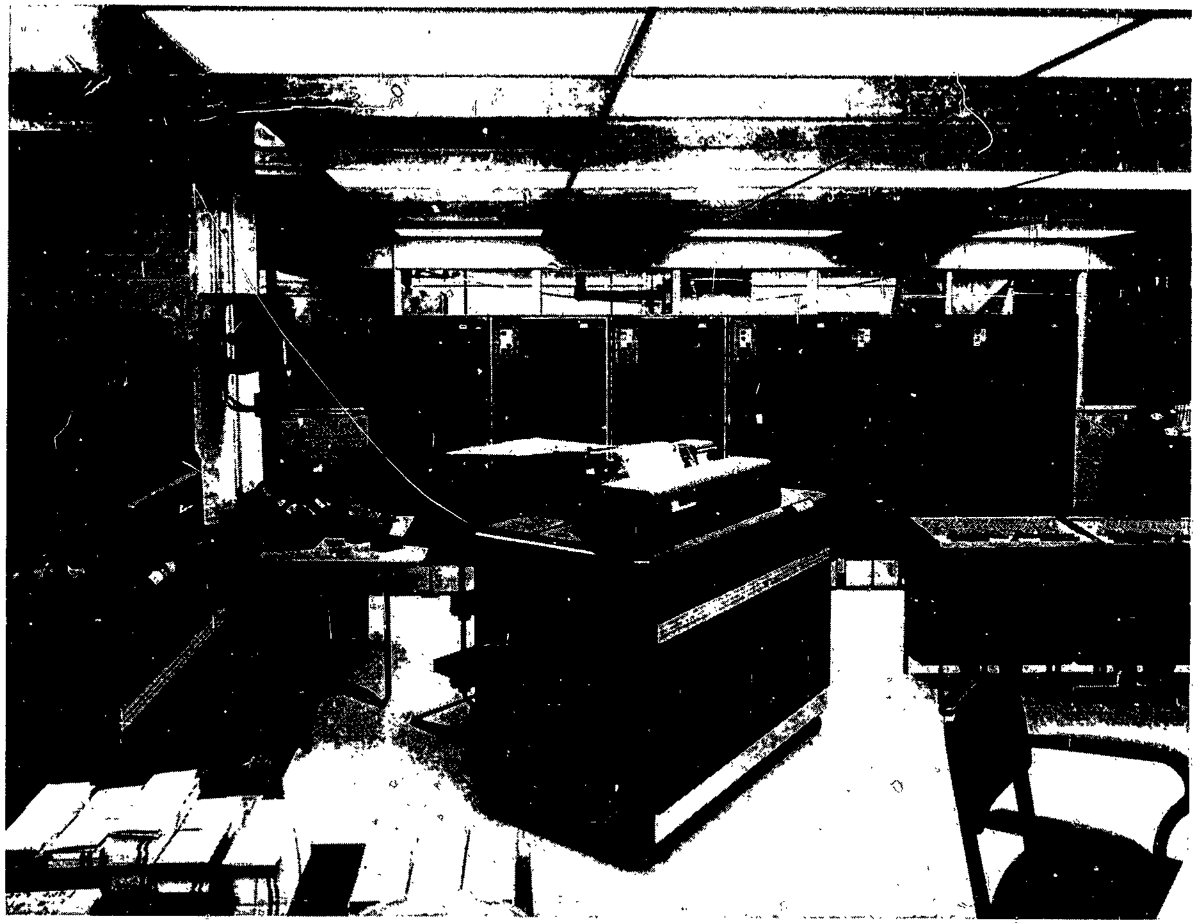


Photo by General Electric Company, Missile & Space Vehicle Dept.

GE

Media	Speed
IBM Cards	250 cards/min (Off line Card Reader)
Magnetic Tape	15,000 or 62,500 char/sec

Space Tech Labs

Magnetic tape and punched cards.

Union Carbide

8 729 II Tape Drives 75 in/sec
4 729 IV Tape Drives 112.5 in/sec
1 711 Card Reader 250 cards/min

Also off line 714 Card Reader (250 cards/min) with 727 Tape Drive (75 in/sec).

Westinghouse

Magnetic Tape	75 in/sec
(IBM 729 II)	15,000 or 42,000 char/sec
Magnetic Tape	112.5 in/sec
(IBM 729 IV)	22,500 or 62,500 char/sec

One of these units may be installed. Character rate varies due to high or low density tape option.

UCLRL

Cards	250 cards/min 24 words/card Binary 72 col/card Decimal
Tapes 729 IV	270 microsec/word low density
Tapes 729 II	400 microsec/word low density

High density values for tapes are 150 microsec/word for 729 II and 100 microsec/word for 729 IV.

OUTPUT

Manufacturer

Media	Speed
Magnetic Tape	See Storage (Recording in BCD or Binary)
Cards	100 cards/min (on-line)
Printed Page	150 lines/min (On-line)
Tape to Printer	150 or 600 lines/min

Tape-to-Card conversion can proceed at 100 or 250 cards/min. The faster rates of conversion are obtained when using the IBM 1401 for off-line tape to card and tape to printer functions.

GE

Cards	100 cards/min
Tape	15,000 or 62,500 char/sec
Printer	150 lines/min (attached to system)
Printer	500 lines/min (tape to printer off line)
Printer	4,000 lines/min (tape to printer off line)

Space Tech Labs

Magnetic Tape	62,500 char/sec
Line Printer	150 lines/min
Cards	100 cards/min (80 column)

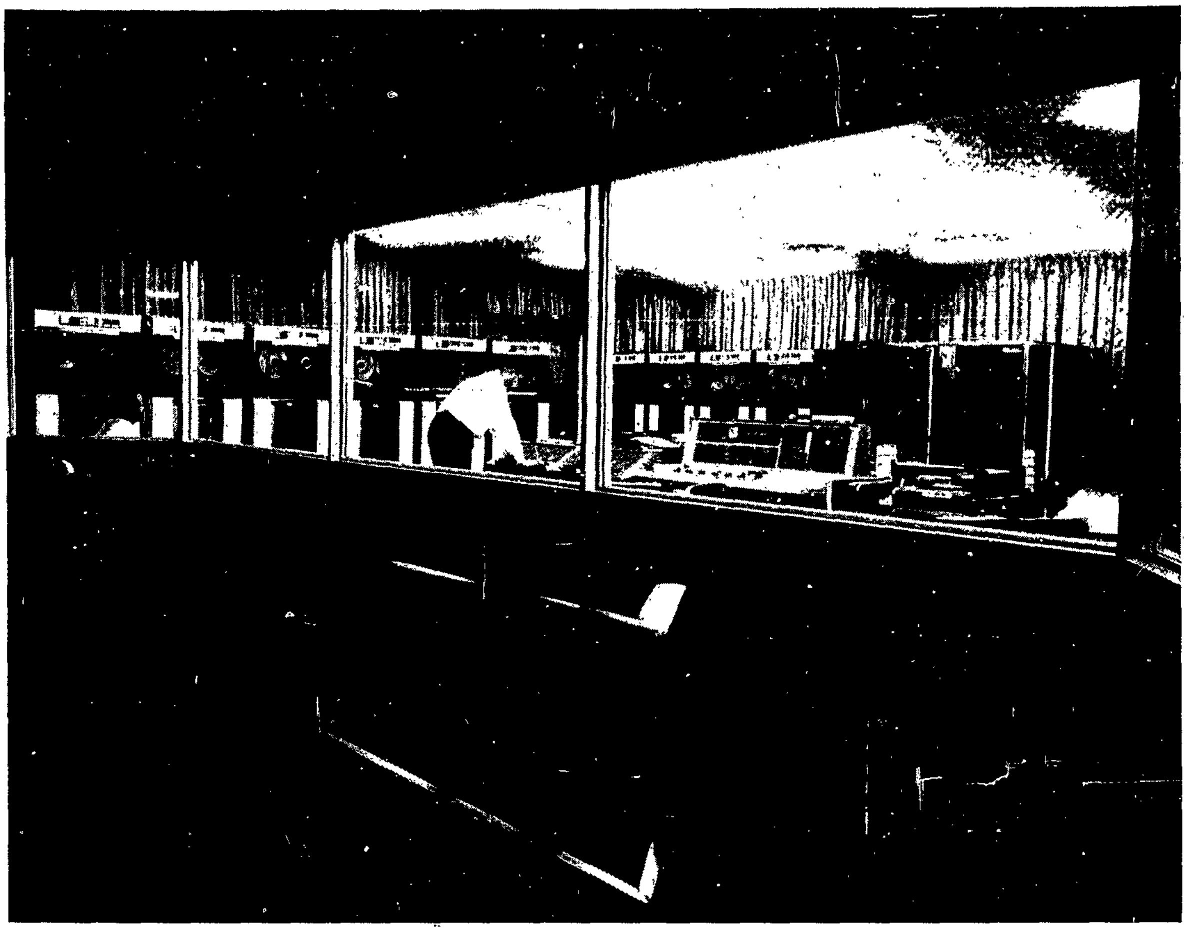


Photo by Space Technology Laboratories, Incorporated

Union Carbide

Media	Speed
Magnetic Tape	
1 716 Printer	150 lines/min
1 721 Card Punch	100 cards/min

Also off line 7204 and 717 printers (500 and 150 lines per minute respectively) with a 727 tape drive each, and an off line card punch - 722 at 100 cards/min with a 727 tape drive.

UCLRL

Printer		150 lines/min 72 chars/line
Tapes	729 II	low density for off-line printer
Cards		100 cards/min 24 words/card Binary
		72 col/card Decimal

CHECKING FEATURES

Manufacturer

Checking features include accumulator overflow, divide check, floating point overflow, and underflow, data channel I/O check, horizontal and vertical parity check on magnetic tape, dual level sensing, two gap head for verification of tape writing, and echo checking on the line printer.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	5.8 Kw
Weight, computer	17,795 lbs

Physical Planning Manual available on request - IBM Form No. x21-1209.

GE

Power, computer	5.84 Kw	6.9 KVA
Volume, computer	18,000 cu ft	
Volume, air condition	13,800 cu ft	
Area, computer	2,000 sq ft	
Area, air conditioner	160 sq ft	
Room size, computer	50 ft x 40 ft	
Room size, air condition	8 ft x 20 ft	
Floor loading	200 lbs concen max	
Capacity, air conditioner	30 Tons	
Weight, computer	30,000 lbs	

Site preparations include a steel sub-floor, an acoustical hung ceiling, and a room enclosed by double glass and wall board.

Space Tech Labs

Power, computer	35 KVA
Volume, computer	17,000 cu ft
Area, computer	1,700 sq ft
Floor loading	80 lbs/sq ft

Site preparation included a 24-inch false ceiling

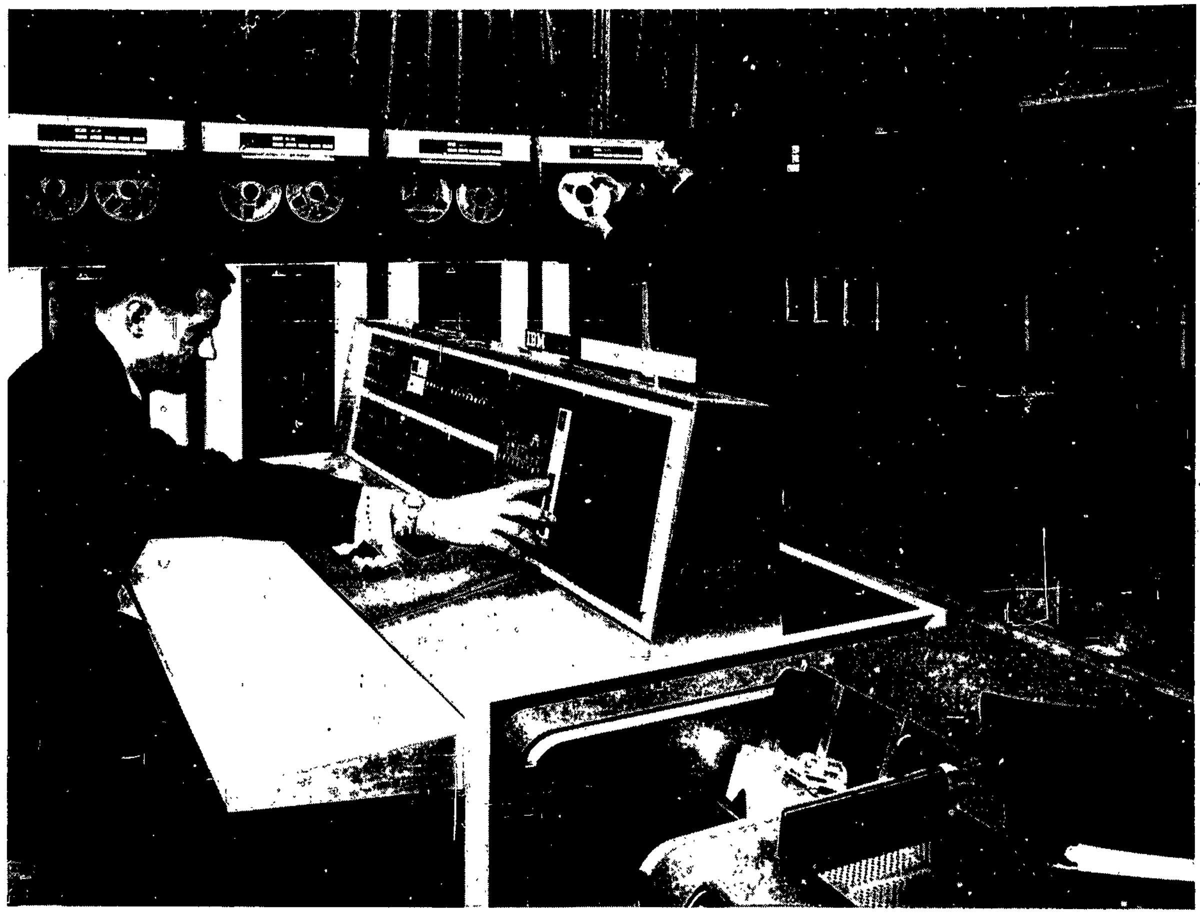


Photo by C E I R, Incorporated

and an 18-inch raised floor. The air conditioning is included in the building system.

Union Carbide

Power, computer	300 KVA
Power, air conditioner	75 Tons
Volume, computer	25,500 cu ft
Volume, air conditioner	3,400 cu ft
Area, computer	3,000 sq ft
Area, air condiioner	400 sq ft
Room size	75 ft x 40 ft
Floor loading	50 lbs/sq ft
	300 lbs concen max
Weight, computer	50,000 lbs

Computer is installed on the 36th floor of an office building which is completely air conditioned and equipped with sealed windows. Structural steel of the 36th floor was lowered 12 inches to allow for raised floor-used for cabling etc. - which was prepared by the Lishe Aluminum Co. and consists of 2 1/2 x 2 1/2 panel. Room will be equipped with false "egg crate" ceiling. Air plenum chamber also used.

Westinghouse

Power, computer	5.84 Kw	6.9 KVA	19.0 pf
Volume, computer		1,030 cu ft	
Volume, air conditioner		96 cu ft	
Area, computer		212 sq ft	
Area, air conditioner		16 sq ft	
Room size		1,000 sq ft	
Floor loading		69 lbs/sq ft	
		80 lbs concen max	
Capacity		3 1/2 Tons	
Weight, computer		14,655 lbs	
Weight, air conditioner		800 lbs	

The air conditioner is to maintain 75°F and 50% relative humidity, assuming 4 persons are in room.

UCLRL

Power, computer	28 Kw	35 KVS	0.8 pf
Power, air cond	22 Kw	32 KVA	0.9 pf
Volume, computer		1,200 cu ft	
Volume, air conditioner		2,000 cu ft	
Area, computer		200 sq ft	
Area, air conditioner		360 sq ft	
Room size, computer		25 ft x 40 ft	
Room size, air conditioner		12 ft x 30 ft x 10 ft	
Floor loading		30 lbs/sq ft	
		500 lbs concen max	
Capacity, air conditioner		30 nominal Tons	
Weight, computer		30,000 lbs	
Weight, air conditioner		16,000 lbs	

Site was previously occupied by an IBM 704, so preparation consisted of drilling some new cable holes in concrete floor and rerouting cope trays.

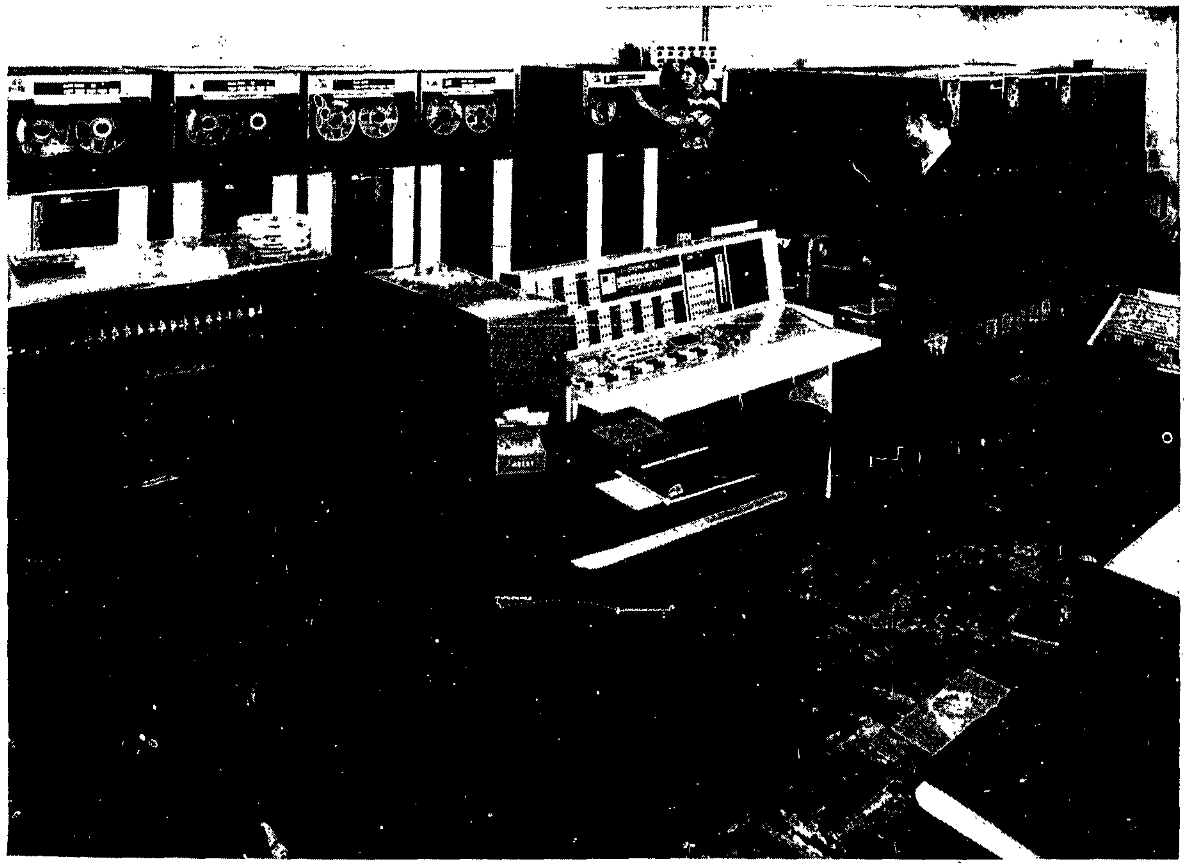


Photo by University of California Lawrence Radiation Laboratory

PRODUCTION RECORD

Manufacturer

Time required for delivery	18 - 24 months
Number of systems produced	Over 8

COST, PRICE AND RENTAL RATES

Manufacturer

Type	Description	Model	Monthly Rental	Purchase Price
711	Card Reader	2	$ 800	$32,000
716	Printer	1	1,200	54,200
721	Card Punch	1	600	25,000
729	Magnetic Tape Unit	2	700	27,500
729	Magnetic Tape Unit	4	900	48,500
7100	Central Process Unit	1	16,975	707,500
7151	Console Control Unit	1	1,225	61,700
7302	Core Storage	1	19,800	950,000
7606	Multiplexor	1	3,900	156,300
7607	Data Channel (Tape and Card)	1	4,500	208,400
7607	Data Channel (Tape)	2	3,500	169,900
7608	Power Converter	1	1,600	60,000

Monthly rental, typical system: $63,500
Purchase price, typical system: $2,898,000
Maintenance contract available.

Space Tech Labs
System cost is $2,949,000 and rental rate is $66,100 per month.

Union Carbide
2 channel IBM 7090, with I/O equipment listed, rents at about $76,000.

Westinghouse
IBM 7100, IBM 7302, IBM 7607, 10 IBM 729 II, IBM 7151, IBM 7606, and IBM 7608 rent for $60,000/month. Maintenance and serive provided by manufacturer included in monthly rental.

UCLRL
IBM 7151, 7302, 7100, 7606, 7607, 7608, 7617, 7617, 7618 purchased for $2,313,800.
IBM 716, 711, 721, ten 729's rent at $11,600/month.
Maintenance contract at $2,500/month.

PERSONNEL REQUIREMENTS

Manufacturer
Education, training, program testing, technical assistance are provided.

GE

	Three 8-Hour Shifts Used	Recommended
Supervisors	3	3
Analysts	20	30
Programmers	17	20
Coders	10	12
Clerks	1	1
Librarians	1	1
Operators	3	4
Input-Output Oper	4	5
Tape Handlers	3	4
Scheduler	1	1

Operation tends toward open shop.

Methods of training used include on-the-job training and IBM School.

Space Tech Labs

	Three 8-Hour Shifts
Supervisors	15
Analysts	6
Programmers	60
Clerks	2
Librarians	1
Operators	7
Engineers	1
Technicians	2
Input-Output Oper	2
Tape Handlers	1

Operation tends toward closed shop.

Methods of training used includes IBM local short courses, internal two-week courses, and on-the-job training.

Union Carbide

	One 8-Hour Shift
Supervisors	6
Programmers	16
Operators	2
In-Output Oper	1
Tape Handlers	1

Operation tends toward closed shop.

Methods of training used includes IBM and internal training courses.

Applications programmed outside the department will be accepted for running on the 7090 by EDP personnel. In other words, programming is, if desirable, open shop, operations are closed shop.

UCLRL

	Seven days/week Three 8-Hour Shifts
Supervisors	1
Programmers	21
Coders	5
Librarians	1
Operators	10

Operation tends toward open shop.

Personnel are trained by working with an experienced person.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

GE

Average error-free running period 110 Hours
Good time 110 Hours/Week (Average)
Attempted to run time 120 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.916
Above figures based on period 16 Jun 60 to 14 Aug 60
Passed Customer Acceptance Test 16 Jun 60
Time is available for rent to qualified outside organizations.
Time is made available, on none interference basis, to other government contractors.

Space Tech Labs

Passed Customer Acceptance Test July 1960

Westinghouse

System installed in May 1961.

UCLRL

Good time 110 Hours/Week (Average)
Attempted to run time 150 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.75
Above figures based on period 1 Jul 60 to 15 Jul 60
Passed Customer Acceptance Test 1 Jul 60
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include high speed, compatibility with IBM 704 and 709 systems, a rich operation code set, and a very fast memory.

Unique system advantages include overlap of input/output operations with computing with very low memory interference rate and automatic interrupting facilities permitting I/O devices to interrupt main program. Many special features and attachments are available on a "Request for Price Quotation" basis: (i.e.) Cathode Ray Tube pictorial output, clocks, extended precision arithmetic, direct data I/O device, tape switch, etc.

Manufacturer's recommendations for the care and handling of magnetic tape:

Storage for frequent or infrequent usage (Mylar Base) at relative humidity 0 to 80% (The upper limit on humidity is given to prevent the formation of fungus and mold growth. This limit may be exceeded by hermetically sealing the tape in a plastic bag.) and temperature 40 to 120°F.

The tape should be stored in a dust proof container. Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, it must be reconditioned by allowing it to remain at the given condition for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours.

General Precautions

The tape should not come in contact with magnetic material at any time and should never be subjected to strong magnetic fields. Either of these can cause the loss of information or the introduction of noise.

When shipping magnetic tape, the reel should be placed in a dust-proof container and hermetically sealed in a plastic bag. Additional support should be obtained by enclosing in an individual cardboard box.

GE

Outstanding features include column binary, on line clock, speed necessary to meet schedules, capacity large enough to handle our largest programs, and size (not cumbersome machine to operate).

Customer asks for tapes to be assigned to him although physical use of tapes are under control of tape librarian. The customer maintains a log of what he has been assigned and releases the tapes as data is no longer of any value. Stored in special design plastic containers under humidity and temperature controlled conditions.

Smithsonian Institution

The Smithsonian Institution will use an IBM 7090 System at its Astrophysical Observatory for four hours during the day. The rest of the time is to be made available, by contract, to Computer Services, Inc. of Englewood, New Jersey, for purchase and resale.

General Motors
Allison Division
Indianapolis 6, Indiana

The 7090 is scheduled for shipment. The specifications and prices are as follows:

Qty	Unit	Monthly Rental
1	711	$ 812.00
1	716	1,218.00
1	721	609.00
18	729 IV	at 913.50
1	7100	19,589.50

The above price includes the 8K nullification RPQ at $25.00

1	7151	1,243.38
1	7302	17,762.50
1	7606	3,958.50
1	7607-1	4,339.13
1	7607-2	3,324.13
1	7608	710.50
2	7617	228.38
1	7618	913.50

Martin Company
Denver, Colorado

IBM 7090 System to consist of a 7608, 7618, 7607, (2) 7100's, 7606, 7302, 7607, (20) 729's, (2) 7617's, 7151, 711, and 716.

FUTURE PLANS

GE

The 7090 will be using FORTRAN, SOS, and SAP as major assembler comilers as well as a generalized data processing system for technical data systems.

A production monitor with programs on a master tape as subroutines will be used. This system will have built-in time checking of an on-line clock and will work along with the systems mentioned above.

A link to combine MSVD's analog computer with the 7090 is almost ready for operation.

It is anticipated that two IBM 1401 Systems and/or one GE 225 System will be added in 1961. These systems will be used primarily as input-output equipment for the 7090.

INSTALLATIONS

U. S. Army Ordnance Missile Command
Redstone Arsenal, Alabama

U. S. Navy David Taylor Model Basin
Washington 7, D. C.

Aerospace Technical Intelligence Center
Wright Patterson Air Force Base, Ohio

U. S. Air Force Flight Test Center
Data Processing and Computing Branch
Edwards Air Force Base, California

U. S. Air Force Mathematical Services Laboratory
Eglin Air Force Base, Florida

Wright Air Development Center, ARDC
Directorate of Systems Engineering
Wright Patterson Air Force Base, Ohio

Allis Chalmers Manufacturing Company
Milwaukee, Wisconsin (Proposed)

Bell Telephone Laboratories
Murray Hill, New Jersey (Proposed)

C E I R, Incorporated
Arlington Research Center
Arlington, Virginia

C E I R, Incorporated
Union Carbide Building
270 Park Avenue
New York, N. Y.

Convair
Fort Worth, Texas

General Electric Company
Large Jet Engine Department
Evendale 15, Ohio

General Electric Company
Evendale Computations Operation
Evendale 15, Ohio

General Electric Company
Missile & Space Vehicle Department
3198 Chestnut Street
Philadelphia 4, Pennsylvania

General Motors Corporation
Research Laboratories
12 Mile and Warren Roads
Warren, Michigan

General Motors Corporation
Allison Division
Indianapolis 6, Indiana

Gulf Research and Development Company
P. O. Drawer 2038
Pittsburgh 30, Pennsylvania (Proposed)

International Business Machines Corporation
Scientific Computation Laboratory
Endicott, New York

International Business Machines Corporation
Data Systems Division
Poughkeepsie, New York

International Business Machines Corporation
Research Center
P. O. Box 218
Yorktown Heights, New York

Lockheed Aircraft Corporation
Missile and Space Division
Sunnyvale, California

The Marquardt Corporation
16555 Saticoy Street
Van Nuys, California

North American Aviation, Inc.
4300 E. Fifth Avenue
Columbus 16, Ohio (Proposed)

Pratt and Whitney Aircraft
Florida Research and Development Center
United, Florida

Rand Corporation
1700 Main Street
Santa Monica, California

Republic Aviation Corporation
Farmingdale, L. I., New York

Sandia Corporation
Albuquerque, New Mexico (Proposed)

Service Bureau Corporation
IBM Plant
San Jose, California

Socony Mobil Oil Company
150 East 42nd Street
New York 17, N. Y.

Space Technology Laboratories, Incorporated
2400 E. El Segundo Blvd.
El Segundo, California

Standard Oil Company of California
Electronic Computer Center
225 Bush Street
San Francisco 20, California

Texaco, Incorporated
P. O. Box 2332
Houston 1, Texas

Union Carbide Corporation
300 Madison Avenue, 1st Floor
New York 17, N. Y.

Westinghouse Electric Corporation
Steam Division
Lester Branch
Philadelphia 13, Pennsylvania

Westinghouse Electric Corporation 4L38
Advance Systems Engineering & Analytical Department
East Pittsburgh, Pennsylvania

Johns Hopkins University
Johns Hopkins Road
Scaggsville, Maryland

University of California
Lawrence Radiation Laboratories
Box 808
Livermore, California

Smithsonian Institution
Astrophysical Observatory

IBM CPC

IBM Card Programmed Calculator

MANUFACTURER

International Business Machines Corporation

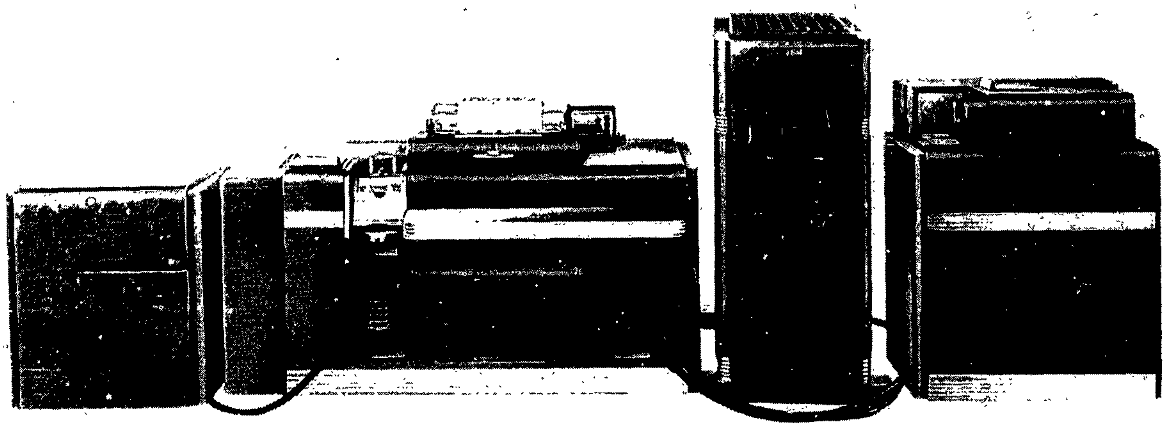


Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

Business and scientific calculating.

U. S. Army Ordnance, Frankford Arsenal

Along with a Burroughs E101 and 2 Univac 120's, the following utilization is made: Field Service National Stock Accounting, fire control instruments, gage accounting, production control, payroll accounting, internal arsenal accounting including fiscal, budget, property and cost accounting, scientific computations in the field of fluid dynamics, interior ballistics, theoretical physics and certain aspects of nuclear physics.

The Griscom-Russell Company

Used for both commercial and scientific work.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	3 or 5
Arithmetic system	Fixed point
Instruction type	One to two address
Number range	Dependent upon programming

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	760
Mult	13,180 (average)
Div	15,480 (average)
Construction	Vacuum tubes

Rapid access word registers	4
Basic pulse repetition rate	50 KC
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	Words	Digits	Access Microsec
Electronic Tubes	9	37	760
Accumulator (Mech)	6	80	400,000-800,000
Mechanical	48	480	400,000-1,200,000

INPUT

Medium	Speed
Card Reader	100-150 cards/min

OUTPUT

Media	Speed
Printed Record	100-150 lines/min
Summary Punch	50 cards/min

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	1,500
Tube types	4

CHECKING FEATURES

Checking may be performed through control panel wiring.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	9.57 KVA
Volume, computer	375 cu ft
Area, computer	64 sq ft
Weight, computer	5,755 lbs

The above figures include the 412/418, 605, 527 Group. Special air conditioning is not required.

PRODUCTION RECORD

Number produced	693
Number in production	0
Delivery time	Out of production

COST, PRICE AND RENTAL RATES

Manufacturer

Approximately $2,200/month and up.

The Griscom-Russell Company

Basic system $2,000/month, additional equipment $1,000/month.

PERSONNEL REQUIREMENTS

The Griscom-Russell Company

One 8-hour shift requires one engineer and three technicians or operators.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Average service time for all machines is approximately 25 hours/month.

ADDITIONAL FEATURES AND REMARKS

The IBM Card-programmed Electronic Calculator solves problems involving any number of sequential steps to obtain a single solution. It is a combination of several units, including three standard IBM machines, and has many applications in engineering, scientific and actuarial computations. One standard unit is an electronic calculator capable of 2,174 additions and subtractions or 86 multiplications and divisions a second. Other units include an accounting machine for interpreting instructions and for accumulating and printing results, a storage unit for retaining data for later use in a problem and a punching unit for recording results in IBM cards.

Numerical instructions in IBM cards direct the sequence of operations. These instructions tell the electronic calculator where to obtain factors; whether to add, subtract, multiply or divide, and what to do with the result-print it, punch it, hold it for later use, or perform combinations of these possibilities.

When not being used for this type of computation, the accounting machine and electronic calculator may be disconnected and used to perform standard accounting and computing operations.

INSTALLATIONS

U. S. Army Ordnance, Frankford Arsenal
Philadelphia, Pennsylvania

NASA
Langley Field, Virginia

Allis-Chambers Manufacturing Company

Battelle Memorial Institute
Columbus 1, Ohio

Esso Standard Oil Company
New York 19, New York

The Griscom-Russell Company
Massillon, Ohio

Republic Aviation Corporation
Farmingdale, Long Island, New York

United Aircraft Corporation
East Hartford 8, Connecticut

IBM STRETCH

IBM Stretch Computer

MANUFACTURER

International Business Machines Corporation

Photo by the International Business Machines Corporation

APPLICATIONS

Engineering development, scientific research, real time processing and control, logistics, procurement and supply, production scheduling and control, and other areas of application.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary and decimal
Binary and decimal digits/word	64 bits or 16 digits
Binary digits/instruction	32 or 64
Instructions per word	1 or 2
Instructions decoded	154 basic
Arithmetic system	Fixed and floating point

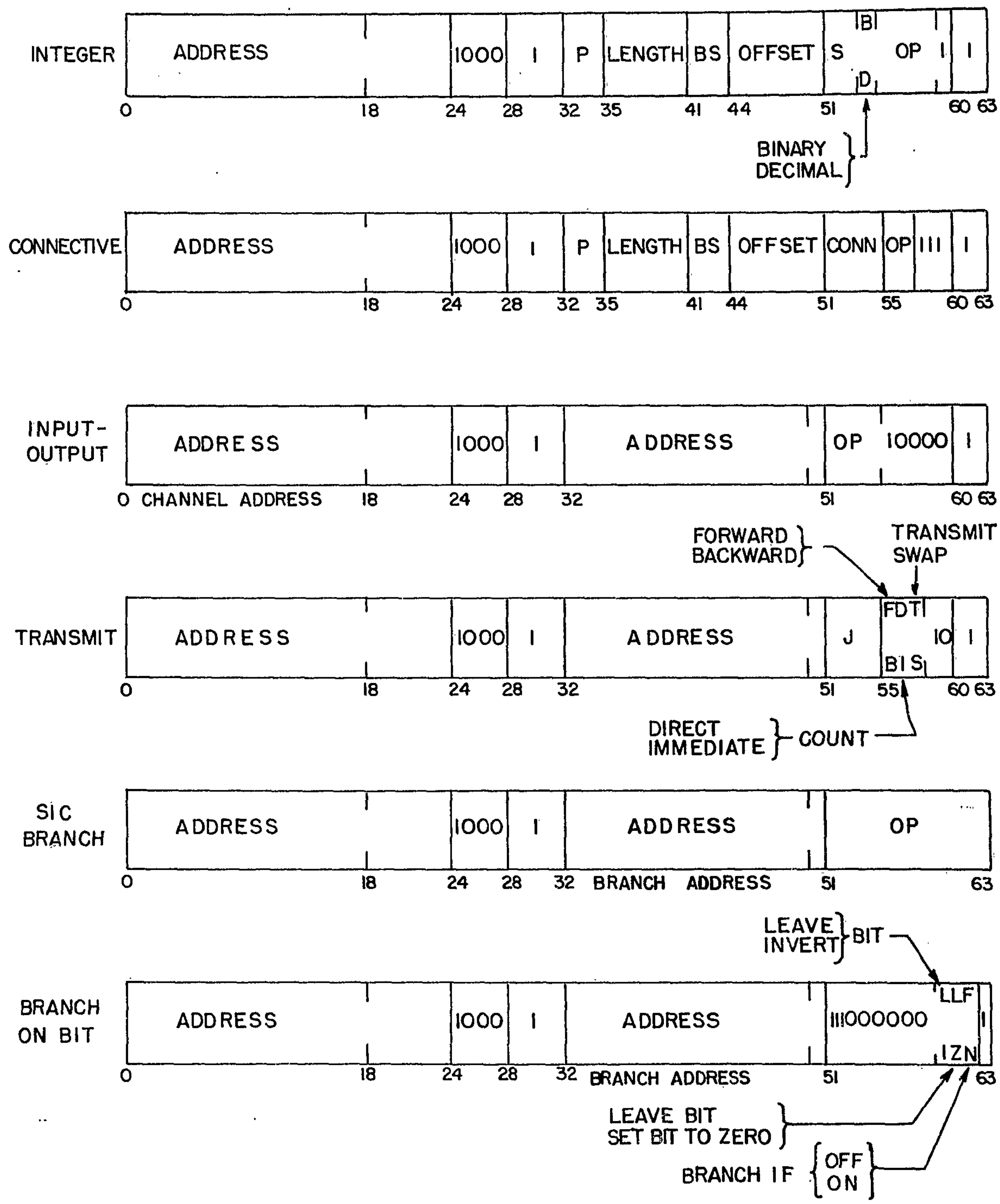
Binary and Decimal Integer Arithmetic for variable length fields

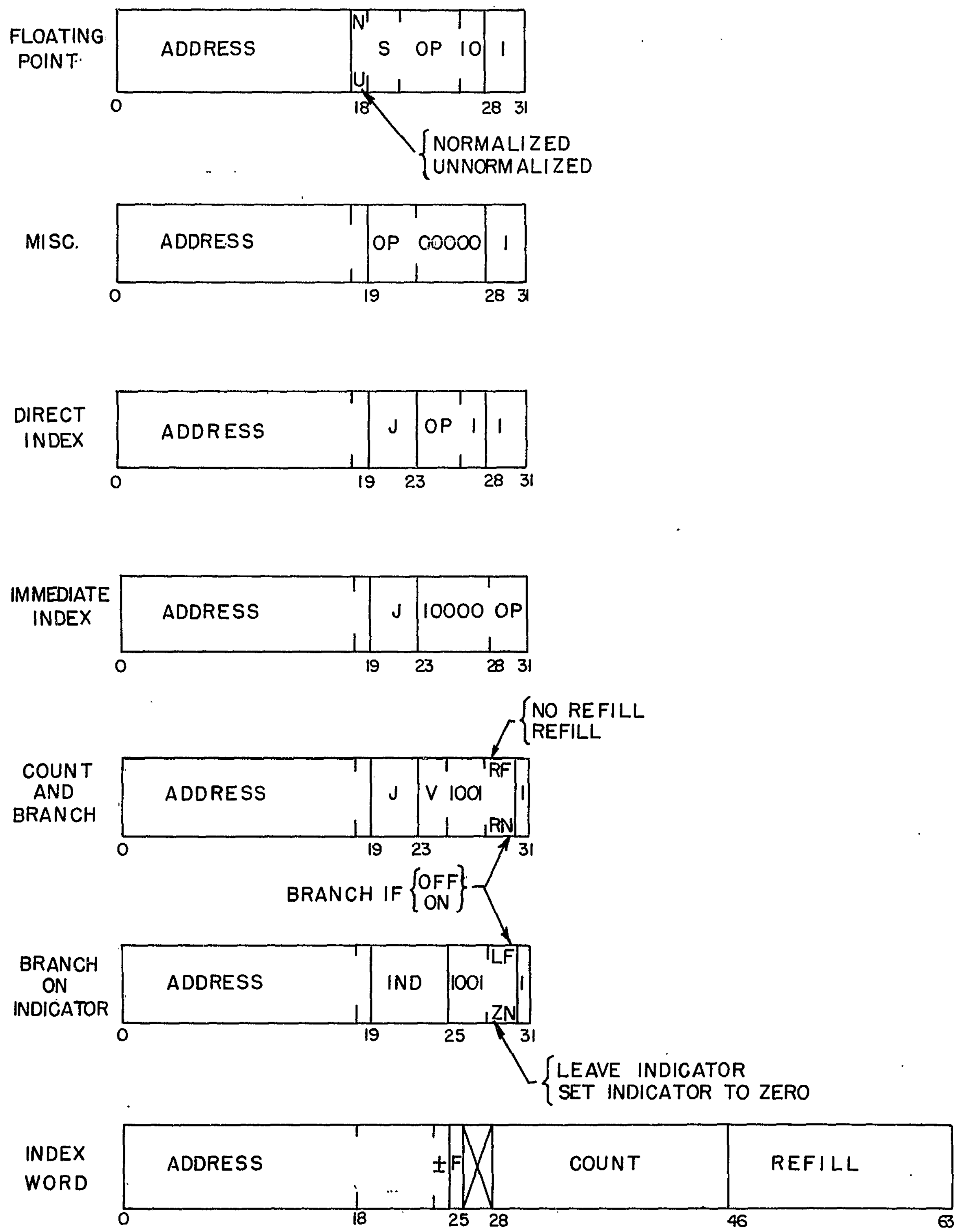
Instruction type	One and two address
Number range	$-2^{1024} < N < 2^{1024}$ for floating point with a 48 bit fraction

Integer arithmetic:

$$0 \leq N < 2^{64} \text{ or } 0 \leq N < 10^{16}$$

INSTRUCTION WORD FORMAT




FLOATING POINT
ADDRESS
N
U
S
OP
10
I
0
18
28
31
NORMALIZED
UNNORMALIZED
MISC.
ADDRESS
OP
00000
I
0
19
28
31
DIRECT INDEX
ADDRESS
J
OP
I
I
0
19
23
28
31
IMMEDIATE INDEX
ADDRESS
J
10000
OP
0
19
23
28
31
NO REFILL
REFILL
COUNT AND BRANCH
ADDRESS
J
V
1001
RF
RN
I
0
19
23
31
BRANCH IF
OFF
ON
BRANCH ON INDICATOR
ADDRESS
IND
1001
LF
ZN
I
0
19
25
31
LEAVE INDICATOR
SET INDICATOR TO ZERO
INDEX WORD
ADDRESS
±
F
COUNT
REFILL
0
18
25
28
46
63

Automatic built-in subroutines
  Square Root
  Radix Conversion
  Transmit
  Swap
  Automatic Subroutine-entry codes
  Automatic priority processing through interruption system
  Multiply and Add operation for both floating point and integer arithmetic

Automatic coding
  STRAP I
  704-709-7090 Simulator
  STRAP II
  704-709 Simulation
  SMAC (MACRO Generator)
  SMCP (master control program)
  FORTRAN

Registers and B-boxes
  16 index registers
  20 addressable special registers
    Special addressable registers include:

Interval timer	Function through interrupt
Elapsed Time clock	system to provide elapsed time and time of day indication.

Interruption address - Base address of interrupt system fix-ups routines.

Upper Boundary	Enable protection of areas of
Lower Boundary	main core store to facilitate
Boundary control bit	multiprogramming ability.

Maintenance bits
Channel Address
Other CPU
Left Zeros count
All ones count
Left half of accumulator
Right half of accumulator
Accumulator Sign

Indicators	Set by interrupt system or
Mask	programmer to provide flex-
Remainder	ibility in interrupt hand-
Factor	ling.
Transmit	

A variety of modifiers apply to different instruction classes and lead to a total of 2,975 individual operations e.g., there are two transmit instructions, TRANSMIT and SWAP. Two modifiers, count forwards or backwards, and immediate or direct address of count value, give a total of 8 transmit orders.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	N/A-Overlapped	1.38 to 1.50
Mult	N/A-Overlapped	2.48 to 2.70
Div	N/A-Overlapped	9.00 to 9.90

Timing given for floating point. Precise time unknown. Design incomplete.

Construction (Arithmetic unit only)

Transistors	Approx 200,000 for complete system
Magnetic Cores	Special index core storage and exchange memory

Arithmetic mode   Serial and parallel

Index arithmetic unit, 24 bits in parallel; Parallel 48 or 96 bit arithmetic for floating point; Serial binary or decimal integer arithmetic (1 to 8 bits in parallel). Note that instructions address words, fields, or bits for arithmetic operations.

Timing   Asynchronous

System is asynchronous for input-output devices, central processing unit operation, including instruction preparation, memory operation and execution.

Operation   Concurrent

Additional Features of Operation: The high degree of overlapped and asynchronous operation, together with two new devices, the instruction processor and look-ahead, not only permit concurrent operation of input-output and external storage devices with the central processing unit, but also several operations are carried on concurrently within the CPU, i.e., instructions and data may be fetched simultaneously from core storage while other instructions are being prepared for processing and while previously prepared instructions are being executed.

STORAGE

Media	No. of Words	No. of Dec/Digits	Microsec
Magnetic Core	16,384 to 262,144	262,144 to 4,194,304	0.5 to 2.18
Magnetic Disk	2,097,152 to 67,108,864	33,554,432 to 1,073,741,824	0 - 215,000

Magnetic core storage unit modules may each operate independently and simultaneously due to an interleaving of addresses within the modules and the operation of the instruction processor and look-ahead. With as many as four modules each of which may be referenced simultaneously, an effective core storage cycle of 1/2 microsecond may be realized for data and similarly with six modules, two for instructions and four for data permit up to 2,000,000 instructions and 2,000,000 data words to be referenced each second, giving an effective storage cycle of 1/2 microseconds for both instructions and data.

Magnetic Tape

No. of units that can be connected	256 Units
No. of chars/linear inch	200 or 556 Chars/inch
Channels or tracks on the tape	6 Tracks/tape
Blank tape separating each record	3/4 Inches
Tape speed	112.5 Inches/sec
Transfer rate	22,500 or 62,500 Chars/sec
Start time	7.3 Millisec
Stop time	7.3 Millisec
Physical properties of tape	
Width	1/2 Inches
Length of reel	2,400 Feet
Composition	Mylar

INPUT

Media	Speed
Punched Cards	1,000 cards/min

Multiple card readers may be included in the system operating simultaneously.

Magnetic Tapes (8 per channel)   62,500 char/sec

Up to 8 magnetic tape units may be in simultaneous operation (one per channel).

Typewriter, Keys Switches   Manual

Keyboard, switches, and keys are part of operator's console which functions like I/O devices. Multiple consoles may be attached for simultaneous operation.

Input-output devices are all controlled by the exchange, an asynchronously and concurrently operating component of the system. The exchange may have from 8 to 32 channels, each of which permits the simultaneous operation of its input-output device through

appropriate control units.

OUTPUT

Media	Speed
Magnetic Tapes (8 per channel)	62,500 char/sec
Punched Cards	250 cards/min
High Speed Printer	600 lines/min
Typewriter, direct digital display, lights	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Solid state construction used throughout.
Tubes None

CHECKING FEATURES

Checking features include single error correction and double error detection on all information transfers between core storage and the central processing unit, disk synchronizer and exchange, parity checking within the CPU and also in all I/O units, and residue checking of all arithmetic operations in parallel arithmetic unit.

Connective operations including automatic tests and counts allow facile programmed testing of data in the system with various parity and checking features contained within the data.

A unique error scanning and recording device automatically records the entire machine state, should malfunction occur.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	100 Kw	110 KVA	0.9 pf
Power, air conditioner	75 Kw	94 KVA	0.8 pf
Volume, air conditioner		5,400 cu ft	
Area, air conditioner		600 sq ft	
Room size, computer		2,500 sq ft	
Room size, air conditioner		600 sq ft with cooling tower	
Floor loading		100 lbs/sq ft	
		1,000 lbs concen max	
Capacity, air conditioner		60 Tons	
Weight, computer		70,000 lbs	

Figures are for "average" system.

Temperature and humidity requirement with machine power on is 50-80°F and 20% to 80%, relative. Cooling air will, in general, be furnished through plenum chambers under false floor.

Power service requirements include 400 cycle, 208 volts, 3 phase, 5 wire (This 400 cycle power may be derived from a motor generator set supplied by the customer. A five wire service should be provided consisting of three phase conductors, one neutral conductor and one equipment ground. Each phase conductor should be sized to carry 300 amperes).

60 cycles, 208 volts, 3 phase, 5 wire (This 60 cycle power should be obtained from a balanced 208 volts, 3 phase source. Should an MG be used to supply the 400 cycle power, the same 60 cycle source may be used. A five wire service should be provided consisting of three phase conductors, one neutral conductor and one equipment ground, each phase conductor should be sized to carry 210 amperes).

PRODUCTION RECORD

Delivery on contract basis

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Solid state construction is used throughout. Automatic error checking and correction and automatic maintenance scanning and recording facilitates troubleshooting.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include simultaneous operation, high speed of auxiliary storage and high speed of indexing and floating point operations.

Unique system advantages include an ability to run and interrupt several programs simultaneously.

FUTURE PLANS

The exchange and central processing unit provide an adequate set of commands control lines, and data paths to permit the attachment of many types of input output devices. Future I/O devices can be designed for direct attachment to the exchange without requiring alterations of the exchange or central processing unit.

INSTALLATIONS

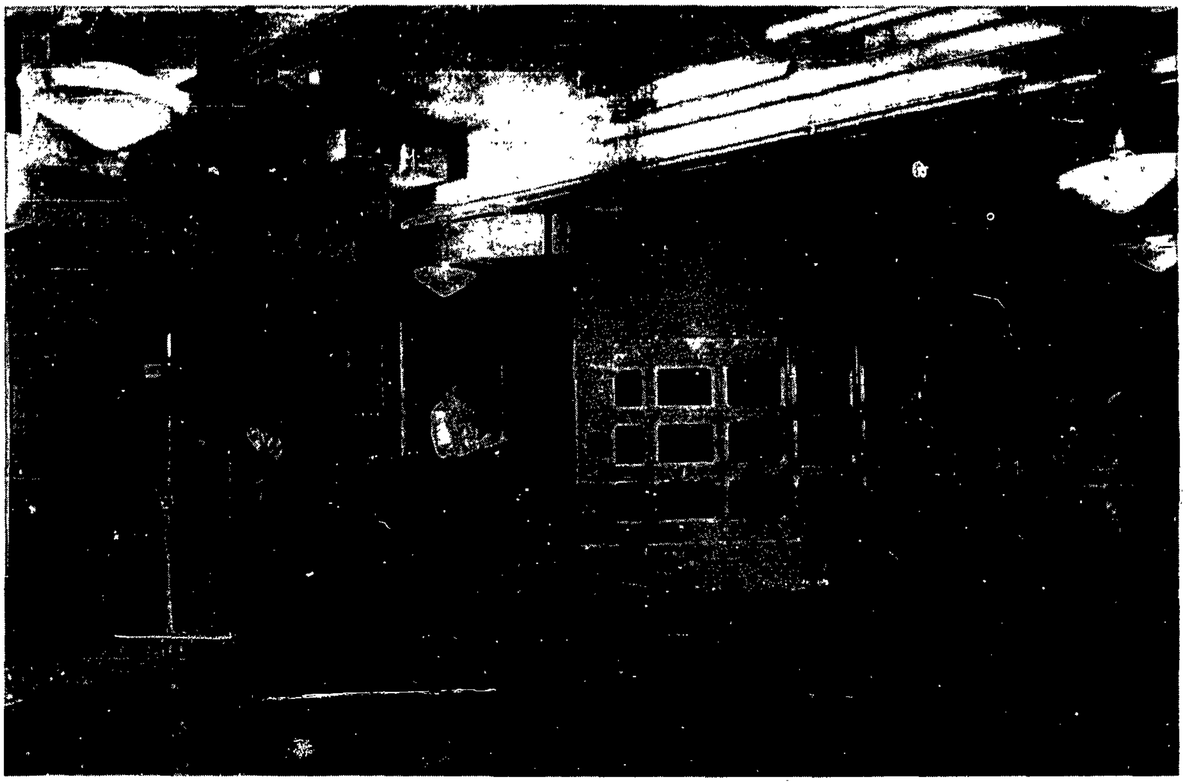
University of California
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

ILLIAC

Illinois Automatic Computer

MANUFACTURER

University of Illinois



Illiac

Photo by University of Illinois

APPLICATIONS

The following typical use was made of the ILLIAC during September 1959:

Use by Departments

	Hrs:Min
Classes	:24
Agricultural Economics	2:36
Aeronautical Engineering	1:34
Agronomy	20:43
Marketing	:13
Animal Science	8:09
Astronomy (Nonr 1834(22))	:42
Astronomy (NSFG 5512)	:10
Bureau of Educational Research	28:30
U. S. Navy (9840-0383)	:59
Veterinary Medicine (MD 728 Off. Surg. Gen.)	:32
Veterinary Medicine (E 2087)	:14
Veterinary Medicine (Exp. Sta. 70-316)	:06
Chemistry	85:49
College of Medicine	:04
Coordinated Sciences Laboratory	52:53
Botany - Eastern Illinois University	:41
Electrical Engineering (NSFY 32-40-266)	10:35
Electrical Engineering (NSFG 7421)	1:31

	Hrs:Min
Electrical Engineering (AF 6079)	1:02
Electrical Engineering	1:44
Education	2:57
Economics (NSFG 7056)	6:21
Economics	:27
Digital Computer Laboratory (Task 27)	14:09
Digital Computer Laboratory (AEC-AT(11-1) 415)	2:00
Digital Computer Laboratory	:04
I. R. E. C.	:07
Physics (Nonr 1834(12))	:57
Physics (AF 662(46-22-55-302))	:12
Physics	7:47
Music	:05
Stanford Research Center (Nonr 2778(100))	3:14
Psychology (AF 49(638)371)	7:50
Psychology P.H. 1715)	11:49
Psychology (ONR 1834(11))	:26
Psychology	24:24
Sociology (Ford Found. 44-32-69-329)	:38
Sociology	2:31
Structural Research (AF 464)	3:39
Structural Research (A.A.S.H.O. Road Test)	1:52
Structural Research (NSF 6572)	3:05
Structural Research (Hwy. Brdg. 47-22-20-307)	6:58

	Hrs:Min
Structural Research	26:28
Theor. and Applied Mechanics (ORD 593)	:17
Theor. and Applied Mechanics	2:06
State Water Survey (SC 75055)	3:22
State Water Survey	:26
Institute of Communications Research (PH 9067C)	1:07
Mechanical Engineering (Martin Co.)	2:00
Mechanical Engineering	4:10
Mining and Metallurgical Engineering (AF 3789)	:08
Mining and Metallurgical Engineering	3:10
Zoology	7:14
Mathematics	2:36
Michigan State University	2:19
Physical Education	:09
	382:39

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	40
Binary digits per instruction	20
Instructions per word	2
Instructions decoded	112
Instructions used	62
Arithmetic system	Fixed point
Instruction type	One address

Number range -1 to $1 - 2^{-39}$

The 20 digits (Half of a word) for the instruction are divided so as to utilize 8 digits for the instruction type (command digits), 10 digits for the address, and 2 digits are unused spares.

ARITHMETIC UNIT

	Inc. Stor. Access Microsec	Excl. Stor. Access Microsec
Add time	93	40
Mult time	665 - 865	620 - 820
Div time	950	900
Construction	Vacuum tubes	
Rapid access word registers	6	
Arithmetic mode	Parallel	
Timing	Asynchronous	
Operation	Sequential	

The figures for operation time including storage access include the access time for the operand and pro-rated access for the instruction.

STORAGE

Media	Words	Digits	Microsec Access
Electrostatic (CRT)	1,024	40,960	18 to 36
Magnetic Drum	12, 800	512,000	1,280 to 16,900

Instructions for drum access require 40 binary digits with 14 binary digit addresses. This address specifies the location of the word desired. Subroutines are employed for block transfers between drum and electrostatic storage.

INPUT

Media	Speed
Punched Paper Tape	300 char/sec

Five hole teletype tape is used. Numerical data is read with a 4-hole code. Alphanumerical data employs a 5-hole code and a special instruction.

OUTPUT

Media	Speed
Punched Paper Tape	60 char/sec
Page Printer	10 char/sec
Cathode Ray Tube	500 points/sec

A teletype BRPE Punch is used. The CRT has a 256 x 256 raster.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	4,427
Tube types	27
Separate cabinets	4

Above figures exclude power supplies.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	27.2 KW
Power, air conditioner	7.0 KW
Space, computer	700 cu ft. 100 sq ft.
Weight, computer	4,000 lbs.
Capacity, air conditioner	10 Tons

PRODUCTION RECORD

Produced	4	Copies at Mich State University, Iowa State University, and University of Sidney
Operating	4	

COST, PRICE AND RENTAL RATES

Approximate cost of basic system	$300,000
Approximate cost of additional equipment (Estimated)	200,000

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
3-8 Hour shifts	4	3

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Error Frequency and Analysis

The ILLIAC is normally used for "engineering" and maintenance between 7 a.m. and 10 a.m., and for a check of its performance between 5:30 p.m. and 6:30 p.m. of each weekday. Since the periods between 7 a.m. and 10 a.m. together with certain irregular periods, such as Saturdays and Sundays,

are devoted to a heterogeneous group of engineering, maintenance and laboratory functions, it is more instructive for an error standpoint to look at the periods between 10 a.m. and 7 a.m. of the next day in order to make an observation of the error frequency in the machine. This is the actual period when the machine is designated for use, although certain engineering procedures frequently require the scheduling of extra maintenance time. With this in mind a summary table has been prepared, using the period between 10 a.m. and 7 a.m. of the next day. This table lists the running time when the machine was operating, the amount of time devoted to routine engineering, the amount of time devoted to repairs because of breakdowns, and the number of failures while the machine was listed as running. During the 5:30 - 6:30 period (when the machine is checked), if no errors are to be found, the time is given to the "running column". Each failure was considered to have terminated a running period and was followed by a repair period in preparing this table. Since the leapfrog code is our most significant machine test, the length of time which it has been used on the machine is listed separately together with the number of errors associated with that particular code. This information for the month is presented in Table II.

It is important to notice that, except during scheduled engineering periods, any interruption of machine time that was not planned is considered a failure in this table. In rare cases, where the failure is not known until a later time, it is possible that no repair period is associated with the failure. This overall system has been adopted because it makes it possible for a machine user to estimate directly the probability that the machine will be "running" any instant of time and the probability of a failure during any given interval of running time.

The following table presents a typical summary of errors or interruptions for June 1959:

Source of Error	Quantity of Errors
Control	2
Arithmetic	1
Memory	3
Drum	13
Reader	3
Punch	3
Unknown	7
Input-Output	1
Run-over from Sched. Main.	1
Total Errors	34

The following table shows the distribution of ILLIAC machine time for the month of September 1959:

	Hrs: Min
Regular Maintenance	84:00
Unscheduled Maintenance	22:13
Drum Engineering	21:06
R.A.R.	:11
Leapfrog	16:18
Library Development	3:04
	146:52

ADDITIONAL FEATURES AND REMARKS

New ILLIAC Codes

During the month of September two new routines were added to the ILLIAC Auxiliary Library.

Aux. P21-268 Data Plotter Output Converter II. Under the control of parameters this routine will convert a data tape output by the standard ILLIAC printing routines into a tape suitable for input to the data plotter.

Aux. X15-269 Maximum Speed Sexadecimal Input Preparation for Magnetic Drum and/or Williams Memory. This routine permits loading of the drum and/or Williams memory from the reader at maximum speed. Any information previously assembled on the drum or in the Williams memory is punched out in sexadecimal form in such a manner that the tape (provided with its own bootstrap) can be read in and sum checked at some later time.

ILLIAC Usage

During the month of September specifications were presented for 17 new specifications. This list does not indicate how the ILLIAC was used because large amounts of machine time may have been consumed by problems with numbers less than 1488T. Numbers followed by T are for theses.

1488 T Sociology. Patterns of Inmate Response. The problem is to group questions (55) in terms of common differentiation of 556 subjects. What are some of the common patterns of responses? Which questions can be grouped together? A pattern analysis is used (KSL 294) in which the usual order of persons and responses is reversed.

1489 T Sociology. Subject Similarities. The problem is to group inmates in terms of how they answer questions about prison life and themselves. A pattern analysis is used in the standard way on each of two subsamples of 50 subjects.

Two subsamples are used:
1. To investigate the reliability of the patterns obtained.
2. To compare samples from two different prisons on differences and similarities in patterns of response.

1490 Civil Engineering. Thermal Stresses in Elastic Shells. This is to solve the problem of an elastic shell subject to the transient temperature input associated with high velocity motion through an atmosphere of variable density, although any temperature history input could be used. Two kinds of thin shells are being studied; spherical dome shells and conical shells.

The significance of this analysis lies in the possibility of treating shells under either applied loads or temperature variations by one unified approach.

The method of solution is a finite difference approach, applied successively as time is increased incrementally.

1491 T Economics. Analysis of the Demand for Coffee. The problem consists of estimating price and income elasticities of the demand for coffee in the United States. Yearly data on the coffee demand, prices, stocks, and imports to the United States will be used. For the estimation of the demand equation a limited estimate will be used. No other than standard library routines are involved.

1492 Mechanical Engineering. Nozzle Design for 4" x 4" Blow Down Tunnel. It is intended to design a pair of nozzle blocks for the blow down tunnel in Aerodynamics Laboratory B. The supersonic nozzle profile will be first calculated by the method of characteristics and then corrected for the boundary layer growth along the nozzle. The complicated step-by-step calculations and iterations can easily be handled by ILLIAC.

The fundamental net calculation has been developed under Problem No. 866 and the general boundary layer calculation has also been developed under Problem No. 1189. It is hoped to adapt and modify the codes from Problem Numbers 866 and 1189 so that the final nozzle profile for a certain supersonic test Mach number can be produced.

1493 Botany - Eastern Illinois University. Analysis of Tree Growth. This is a continuation of an earlier problem, Problem No. 1267, in which daily tree growth measurements are analyzed using the standard program, K 16. The best fitting equation for predicting daily growth is being obtained by attempting multiple correlation using different combinations of factors on different species of trees and for different periods of the season.

Part of this newly submitted data are measurements of growth occurring before leaf enlargement during 1958 and 1959, a period which differs markedly from the later growing season. Part of the data are yearly growth ring measurements from 1901-1951. These are to be analyzed in terms of values ascertained from monthly weather bureau records. This second approach using yearly rather than daily growth measurements was conceived because of an evident influence of the previous season upon the growth of trees. It is hoped that by combining an analysis of daily growth during a given year with an analysis of seasonal growth during a number of years it will be possible to evaluate both the immediate and long-range effects of our weather upon tree growth.

1494 Psychology. Situation-Response Analysis of Anxiety Behavior. This study differs from other studies of anxiety, even though it is based on an inventory, because both situations and responses are specified in the structure of the inventory. Four groups of subjects, a total of 348, were presented with the description of some situation and asked to say whether and to what degree he would show each of a sample of emotional responses.

The K-8 routine is to be used to compute Product Moment Correlations, Means and Standard Deviations for each of the responses for the four groups. A factor analysis for each of the groups is to be computed using KSL-1.90 on the Correlation Matrices.

1495 Animal Science. Potassium Requirement for Baby Pigs. This research is intended to ascertain the amount of potassium required for optimal growth by the baby pig. The mathematical method is the method of least squares.

1496 T Veterinary Medicine and Physiology. Strontium and Calcium Metabolism. The replacement of calcium in the diet of young pigs by strontium is being compared to controls receiving calcium, negative controls receiving neither calcium nor strontium, and pigs receiving both ions. ILLIAC is being used to analyze the variance between the treatment groups for the various criterions used, i.e. weight gain, bone calcium, bone strontium, etc.

1497 Agricultural Economics. A Game Theoretic Model for Cattle Feeding. The feeder cattle enterprise is viewed as a game against nature with nature's choices assumed to be restricted to the price-cost situations generated in the last ten years. The farmer's choices consist of six different feeding systems (or linear combinations of these). Four different situations are considered:

1. Payoff matrix in terms of returns per $100 feed fed.

   a. Maximize the minimum return.

   b. Minimize the maximum loss or "regret".

2. Payoff matrix in terms of returns per animal.

   a. Maximize the minimum return.

   b. Minimize the maximum loss or "regret".

This problem may be set up as a linear programming problem with straightforward use of the library routine M15-183.

INSTALLATIONS

Digital Computer Laboratory
168 Engineering Research Laboratories
University of Illinois
Urbana, Illinois (ILLIAC)

University of Sidney
Sidney, Australia (SILLIAC)

Iowa State College of Agriculture and Mechanic Arts
Ames, Iowa (CYCLONE)

Michigan State University
East Lansing, Michigan (MISTIC)

The ILLIAC is a member of the family of machines orginally designed and constructed by the Institute for Advanced Study.

INTELEX AIRLINE RESERVATION

Intelex Airline Reservation Computer

APPLICATIONS

System is designed for the solution of seat reservation and associated problems. It is a special purpose computer designed to solve the problems of data re-arrangement and retrieval.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Decimal digits/word	10
Decimal digits/instruction	10
Instructions per word	One
Instructions decoded	56
Arithmetic system	Fixed point
Instruction type	One address
Instruction word format	

n n n n	I	J	L R	O P
Operand Address	Index Reg No.	Index where Operand Address may be stored	Field Definition	Instruction No.

Registers include one 10-character accumulator register with associated field definition register, and nine 4-digit index registers. There are indirect addressing and add/subtract from memory instructions.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	50 - 140	40 - 130

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	2000 to 10,000	20,000 to 100,000	10
Drums	12,800	128,000	0 to 20,000
Tape Bin	142,800 words/tape 10 tapes/bin	1,428,000 dig/tape 10 tapes/bin	0 to $20x10^6$

Magnetic Tape

No. of units that can be connected	48 Units
No. of chars/linear inch of tape	508 Chars/inch
Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	0.63 Inches
Tape speed	100 Inches/sec
Transfer rate	50,800 Chars/sec
Start time	6 Millisec
Stop time	6 Millisec
Physical properties of tape	
Width	1 Inch
Length of reel	3,000 Feet

MANUFACTURER

Intelex Systems, Incorporated
Associate of International Telephone and Telegraph Corporation

INPUT

Media
Paper Tape
Telegraph

OUTPUT

Media	Speed
Printer	600-900 lines/min
Paper Tape Punch	
Teleprinter	

PRODUCTION RECORD

Number on order	2
Time required for delivery	24 months

PERSONNEL REQUIREMENTS

Training made available by the manufacturer to users include training in programming.

ADDITIONAL FEATURES AND REMARKS

The tape system will do independent off-line searching. Drums contain address and data channels. Data may be assigned random address which are later used to search for the data.

Unique system advantages include rapid access to large volumes of random-stored data. On drums, direct addressing is possible without constant re-arrangement for changing data. Searches may be done for <u>any</u> information contained on tape without regard to the arrangement of data within a particular tape.

ITT BANK LN PROC

ITT Laboratories Bank Loan Processor.

MANUFACTURER

ITT Laboratories
500 Washington Avenue
Nutley 10, New Jersey

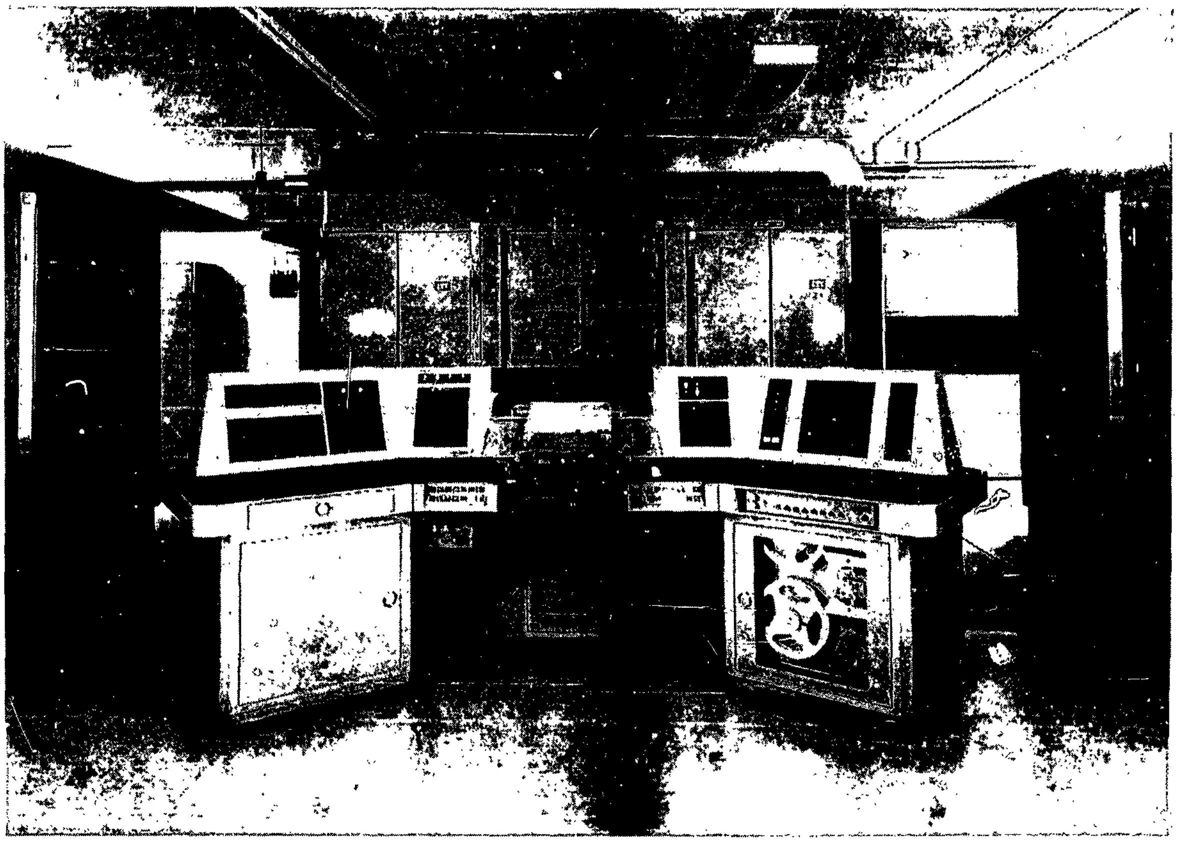


Photo by ITT Laboratories, Nutley

Construction and daily maintenance of magnetic tape file for personal loan operation of third largest U. S. bank, processing of daily inputs and answering of inquiries to this file, print-out of all customer mailings and of numerous internal reports.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	12 + sign
Decimal digits/instruction	12
Instructions/word	1
Instructions decoded	85
Arithmetic system	Fixed point
Instruction type	One address (Modified)

Modified single address (Alpha and Delta, i.e., operand and next instruction address)

Number range $-10^{13} < x < +10^{13}$

Instruction word format

+ and check	1	2	3			7	8				12
	OP CODE		DELTA Next Instr.				OPERAND (or alternate next instruction, or special)				

Automatic built-in subroutines include a sort command, a sequence command, and a merge command.

Automatic coding includes SCP, a Symbolic Conversion Program (One-to-One Compiler for Symbolic Address and Op Codes), and MARK II, a utility system.

Registers and B-boxes include a high and low accumulator, a distributor, an in-out register, and an instruction register.

The system is designed for operating both off-line and on-line, and at the same time. It can simultaneously compute, read tape, write tape, search on several tapes, print (on-or off-line), and answer inquiries.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	170	170
Mult	680-10,710	680-10,710
Div	Programmed	
Construction (Arithmetic unit only)		
Vacuum tubes	0	0
Transistors	1,000	3,000
Condenser-diodes	3,000	10,000
Magnetic cores	-	5,000

The figures are for the arithmetic unit only, excluding the control. The number of cores includes storage and central control.

Arithmetic mode	Parallel-Serial
Timing	Synchronous

"Synchronous" refers to internal logic circuits; however, operation of central section is simultaneous with various in-out operations, the latter proceeding asynchronously with the former.

Operation	Bits of a digit in parallel Digits of a word sequential

STORAGE

Media	No. of Words	No. of Dec Digits	Access Microsec
Magnetic Tape	22×10^6	264×10^6	20,000,000
Magnetic Drum	10,000	120,000	9,000
Magnetic Core	100	1,200	6
Core Buffers	300	3,600	12

No. of units that can be connected	108 Units
No. of char/linear inch of tape	300 Char/inch
Channels or tracks on the tape	22 Tracks/tape
Blank tape separating each record	0.03 Inches
Tape speed	100 Inches/sec
Transfer rate	30,000 Char/sec
Start time	2 Millisec
Stop time	2 Millisec
Average time for experienced operator to change reel	No reels (bin type) Tape exchange is 60 sec.)
Physical properties of tape	
Width	1 Inch
Length of tape in bin	450 Feet
Composition	Mylar sandwich

The 108 units is an arbitrary design goal, not an actual limitation.

The 0.03 inch inter-record gap is an interleaved recording. The opposite-direction record serves as a gap.

INPUT

Media	Speed
Magnetic Tape (ITTL Bin Transports	30,000 dig/sec
Paper Tape (Potter 907)	600 char/sec
Paper Tape (Flexo Reader)	10 char/sec
Keyboard (Flexo, Inquiry)	Manual

OUTPUT

Media	Speed
Magnetic Tape (ITTL Bin Transports)	30,000 dig/sec
High Speed Printer (Shepard w/ITTL Electronics)	20 lines/sec
Typewriter (Flexowriter)	10 char/sec
Punched Tape (Flexo Punch)	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	
Tubes	0
Diodes	30,000
Transistors	10,000
Magnetic Cores	22,000

Some tubes in drum system and P.S., being replaced by transistorized drum system.

CHECKING FEATURES

Sign redundancy. Mod 3 check in several places (arithmetic, bus, output, tape). Parity check on punched tapes and printer data.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	6 Kw
Volume, computer	400 cu ft
Area, computer	80 sq ft
Room size, computer	900 sq ft
Floor loading	75 lbs/sq ft 800 lbs concen max
Weight, computer	4,000 lbs

Site preparations include a separate power main, a regulator, and floor ducts. Area air conditioning only.

PRODUCTION RECORD

Number produced to date	1
Time required for delivery	18 months

Special custom system, using stored program computer. Some elements of the system have been produced for other uses (e.g. tapes).

COST, PRICE AND RENTAL RATES

The computer, drum printer system, tape system (18 Transports) rents at $17,000 to $20,000/month.

36 additional tape transports, and 7 inquiry channels rents at an additional $10,000 to $15,000/month.

Maintenance is contracted to Federal Electric Company at about $6,000/month.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift U	One 8-Hour Shift R	Two 8-Hour Shifts R	Three 8-Hour Shifts U	Three 8-Hour Shifts R
Supervisors	4	2	2		
Analysts	2	1	1		
Programmer	4	3	4		
Coders	2	1			
Clerks	14	14	28		
Operators	1	1	2		3
Engineers	2	1	2	3	3
Technicians	2	1	2	3	3

Operation tends toward closed shop.

Method of training used is by training courses.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Time is not available for rent to outside organizations.

System is under acceptance test.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include transistorization, large processing capacity at medium speed, will maintain 600,000 loans up-to-date daily, about 10^9 bits of data accessible at all times, inquiries answered in less than 20 seconds each, at rate of 20 per minute and simultaneous operation of 12 tape functions, computer processing, and printing. Additional system advantages are that it combines on-line processing and off-line processing by the same equipment. A large data file is in ready access.

Commercial information is available through
Intelex Systems, Inc. (An ITT Associate)
67 Broad Street
New York, N. Y.

FUTURE PLANS

Further applications of this and related hardware to banks, reservations, credit cards, and other commercial and government systems.

ITT SPES 025

ITT Laboratories Stored Program Element System 025

MANUFACTURER

ITT Laboratories
500 Washington Avenue
Nutley 10, N. J.

APPLICATIONS

Located at 54 S, U. S. Route 17, Paramus, New Jersey, the SPES provides automated message handling on a store and forward basis. It employs a multi-sequential stored program computer to handle both routine and complex tasks connected with the message center activity, including standard data processing operations. In this application, the SPES also communicates directly with a large high-speed computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	33
Binary digits/instruction	32 plus parity
Instructions/word	1
Instructions decoded	43
Arithmetic system	Fixed point

One's complement system of arithmetic is used.

Instruction type	One address
Number range	$-(2^{31}-1)$ to $+(2^{31}-1)$

Instruction word format

Interrupt	Variation	Operation	Main Memory Address	Character Address
0 1	2 7	8 13	14 29	30 31

Automatic coding includes a symbolic compiler.

Registers and B-boxes include an accumulator, arithmetic unit buffer, instruction register, 18 other registers, 256 index registers (special "Index" core memory), and 256 program counters (special "Program" core memory).

Each of four sense instructions can sense 128 devices.

Each of two register transfer instructions can address 11 registers.

Most instructions are indexable and repeatable.

Most instructions will operate on full words or on one character. (There are 4 character's per word).

Computer also has a multisequence feature whereby it will interleave the operation of 256 different programs automatically under control of the instructions' interrupt portion.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	16	3

Construction (Arithmetic unit only)

Transistors	2,100
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Tape	24,000,000	33 bits/word	3,000,000
Magnetic Drum	65,536	33 bits/word	8,000
Magnetic Cores	16,384	33 bits/word	8
Magnetic Cores	256	19 bits/word	6
Magnetic Cores	256	17 bits/word	6

Magnetic Tape

No. of units that can be connected	16 Units
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Char/sec
Start time	3 Millisec
Stop time	3 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Plastic

INPUT

Media	Speed
Magnetic Tape (Potter 906)	15,000 char/sec
Phone Lines	600 char/sec max
Punch Cards (IBM 711)	250 cards/min
Computer to Computer	260,000 char/sec

1 word = 4 characters = 32 bits
1 card = 24 words

OUTPUT

Media	Speed
Magnetic Tape	15,000 char/sec
Phone Lines	600 char/sec
Punch Cards (IBM 721)	100 cards/min
High Speed Printer (Burroughs 301)	5 lines/sec, 300 char/sec
Computer to Computer	260,000 char/sec
Display	260,000 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	50,000
Transistors	51,000
Magnetic Cores	600,000

CHECKING FEATURES

Parity on check at buffer on all memories, instruction register, and at buffers to all input-output units.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	30 Kw
Power, air conditioner	32 Kw
Volume, computer	1,000 cu ft
Volume, air conditioner	1,000 cu ft
Area, computer	150 sq ft
Area, air conditioner	100 sq ft
Room size, computer	1,500 sq ft
Room size, air conditioner	400 sq ft
Floor loading	250 lbs/sq ft
	1,250 lbs concen max
Weight, computer	30,000 lbs

Site preparation includes false flooring (cable and air ducting), separate power mains and distribution boards.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	8
Number on order	10
Time required for delivery	12 - 18 months

COST, PRICE AND RENTAL RATES

Basic System
Computer $500,000
Communications Section $500,000
Additional Equipment
Drums (4), tapes (2), printer, punch, reader, with control $750,000.

PERSONNEL REQUIREMENTS

Operation tends toward closed shop.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System tests are in progress.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include multi-sequence operation, permitting up to 256 different programs to run concurrently; built-in executive control; hardware performing jumps in and out of sequences without time loss or programming complication, indexed repeat option; word and character modes; tape and drum transfers to and from core memory under external control; built-in performance monitor sequence; and fully transistorized plug-in construction.

Unique system advantages include on-line operation of up to 256 input-output channels and especially suited as communications message handling center.

FUTURE PLANS

Production for a quantity of duplexed systems being set up under contract, for application in a global message switching network.

Further applications in other areas under planning, such as reservations systems and mail order houses.

Adaptation to variety of communications, data processing, and combined communications and data processing systems.

INSTALLATIONS

ITT Laboratories
54 S U. S. Route 17
Paramus, New Jersey

JOHNNIAC

John (Von Neumann)
Integrator and Automatic Computer

MANUFACTURER

The Rand Corporation

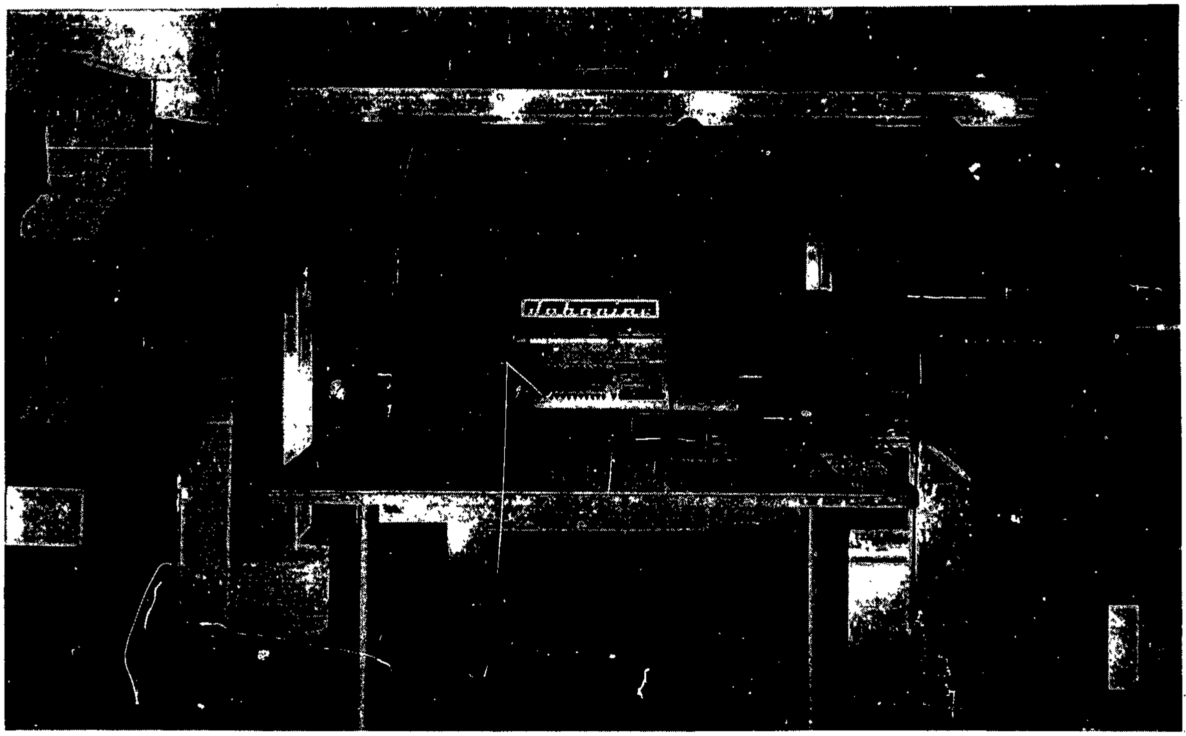


Photo by the Rand Corporation

APPLICATIONS

Scientific and engineering data processing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	40
Binary digits per instruction	20
Instructions per word	2
Instructions decoded	128
Instructions used	Approx. 85
Arithmetic system	Fixed point
Instruction type	One address
Number range	Numerically less than unity.

Negative numbers are represented as complements.

ARITHMETIC UNIT

	Includ. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add time	25	10
Mult time	400	385
Div time	400	385

Construction	Vacuum tubes and transistors
Rapid access word registers	4
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

Addition is concurrent with store cycle. Multiply and divide times are maximum. The transistorized logical adder has a full carry time of 1.5 microseconds.

In 1957, the vacuum tube analog adder was replaced with a transistorized logical adder. The maximum carry time of the new 40-stage adder is 0.8 microseconds. There are about 1200 transistors in the unit. The transistor count includes many logical functions which have been packaged with the adder.

The control has been partly transistorized to gain a significant increase in basic operation rates. Circuit modifications have been limited to control sections affecting basic clear, gate, and shift operations.

STORAGE

Media	Words	Digits	Microsec Access
Magnetic Core	4,096	40/word	15
Magnetic Drum	12,288	40/word	17,000

Drum access time is average access to first word. Sixty microseconds are required for each succeeding address in same channel.

INPUT

Media	Speed
Card Reader	240 cards/min

An IBM collator is used. Both primary and secondary feeds are used.

OUTPUT

Media	Speed
Card Punch	100 cards/min
Printer (ANelex)	1,200 lines/min

An IBM 523 is used. The printer prints 136 columns, 56 char/column (alphanumeric).

During the year 1959 an on-line modified EAI plotter was installed. The 40" x 40" plotter was modified to include straight line drawing ability as well as circle drawing ability. The plotter can be instructed under JOHNNIAC control to go to point X_1, Y_1 and draw a line to point X_2, Y_2. The circle drawing instruction causes the plotter to go to point X, Y and draw a circle of radius r. Point plotting and symbol printing are also available.

In 1959, an on-line ANelex printer was added.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	5,000
Tube types	11
Crystal diodes	500
Magnetic storage cores	163,840
Magnetic switch cores	5,120
Transistors	1,400

CHECKING FEATURES

Manual marginal testing is performed.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	55 KW, 63 KVA, 0.88 PF
Power, air cond.	28 KW
Space, computer	290 cu. ft., 36 sq. ft.
Space, air cond.	180 cu. ft., 50 sq. ft.
Weight, computer	5,000 lbs.
Weight, air cond.	5,000 lbs.
Capacity, air cond.	25 tons

Dimensions of computer are 12 x 3 x 8 feet.

PRODUCTION RECORD

Produced	1
Operating	1

This system was designed and is owned and operated by the Rand Corporation.

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
2-8 Hour shifts	1	2

One technician per shift and one engineer on call is required.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	10 hours
Good time	1,380 hours
Attempted to run time	1,500 hours
Operating ratio (Good/Attempted to run)	0.92
Figures based on period July 1956 to November 1956	
Acceptance test	March 1954

Two transistors of the new arithmetic unit failed during the first year of operation due to defective seals. No failures have occurred since early 1958. This failure record represents two transistor failures in 14,976,000 transistor-hours.

ADDITIONAL FEATURES AND REMARKS

System includes console facilities which report static state of all registers in an octal display, allow manual entry of information via a keyboard, punch contents of all registers and keyboard conditioning switches on a single card, display static state of all toggles and allow manual control over toggle states.

A wired in core store test routine is included which tests all addresses and bits under a variety of information patterns without aid of a stored program.

INSTALLATIONS

The Rand Corporation
1700 Main Street
Santa Monica, California

JUKEBOX

Missile Firing Data Computer JUKEBOX

MANUFACTURER

Autonetics Division
North American Aviation, Incorporated

APPLICATIONS

General purpose computing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	39 + Sync + sign
Binary digits/instruction	20
Instructions per word	2
Arithmetic system	Fixed point
Instruction type	Two address
Number range	$-1 < N < +1$

Instruction word format

Sign	Left Command						Sign	Right Command						Sync
+	1	6	7	7	6	0 0	+	1	6	7	7	6	0 0	1
B	0	0	0	0	0	0 B	B	0	0	0	0	0	0 B	
Operation			Location				Operation			Location				

B - Binary
0 - Octal

Computer uses binary coded decimal and command format on input and output devices only.

Automatic coding
Punched tape teletype code to octal or binary coded decimal during tape fill.
Registers and B-boxes
Two 8-word rapid access storage registers. Five 1-word arithmetic registers.

ARITHMETIC UNIT

	Incl Stor Access Microsec Memory	Incl Stor Access Microsec HS Storage	Exclud Stor Access Microsec
Add	9,590	2,040	540
Mult	19,850	12,300	10,800
Div	20,390	12,840	11,340

Average access time 9,050 microseconds.

Construction (Arithmetic unit only)

Transistors	664
Condensers	673
Diodes	4,401
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Disk	4,096	167,936	9,050

INPUT

Media	Speed
Paper Tape	200 char/sec 20 in/sec
Keyboard	Manual

OUTPUT

Media	Speed
Printer (Typewriter)	11 char/sec (BCD or octal)
Nixie Display Tubes	16 char/17,280 microsec (BCD or octal)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	0
Diodes	5,316
Transistors	885
Magnetic Cores	0

Above figures do not include system and component testers.

CHECKING FEATURES

Component test set: Tests each computer board separately.
Optional in both dynamic and static modes.
System test set: Panel array of neon indicators showing the status of all the flip-flops in a dynamic or static one-shot mode; includes marginal test feature of power supply variation and clock jitter.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.5 Kw	0.9 pf
Volume, computer	4 cu ft	
Volume, parameter	1.25 cu ft	
Volume, tape reader	2.5 cu ft	
Volume, control	1.25 cu ft	
Area, computer	2 sq ft	
Area, parameter	1.25 sq ft	
Area, tape reader	1.25 sq ft	
Area, control	1.25 sq ft	
Room size, computer (weight)	125 lbs	
Room size, parameter (weight)	55 lbs	
Room size, tape read (weight)	45 lbs	
Room size, control (weight)	50 lbs	
Floor loading	35 lbs/sq ft 125 lbs concen max	
Weight, computer	275 lbs, total plus 90 lbs auxiliary equipment	

Air conditioner is not supplied with computer.
Computer operating temperature range 55°F to 110°F
Temperature rise approximately 10°F above room temperature.
Frequency range 50 to 70 cycles/sec
Voltage range 105v, ac to 135v, ac
Auxiliary equipment
Systems tester 2 cu ft, 2.5 sq ft, 38 lbs 60w
Component tester 3.75 cu ft, 2.5 sq ft, 52 lbs 90 w

PRODUCTION RECORD

Number produced to date 5
In addition to the five computers specified, there exist five R&D models operating on 400 cycle power with half the clock rate and computing speed.

PERSONNEL REQUIREMENTS

One operator per 8-hour shift.
Training made available by manufacturer to users includes maintenance and programming.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Several construction features have been incorporated to enhance reliability. These are all solid-state components, gold-plated pins, connectors, and etched circuitry, epoxy-coated boards, closed-loop wiring; wires to gates, power supplies, clock signals are routed back to the origin to retain operation in case of wire breakage, and extensive use is made of time-shared gates and flip-flops to minimize the total number of components.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include simplicity of operation and programming.
Unique system advantages include high-speed visual display of information in memory, either in binary coded decimal or command format.

FUTURE PLANS

This system has been replaced by the FADAC computer.

INSTALLATIONS

Autonetics, a Division of North American Aviation, Inc.
9150 E. Imperial Highway
Downey, California

LEEDS NORTHRUP 3000

Leeds and Northrup Computer 3000

MANUFACTURER

Leeds and Northrup Company

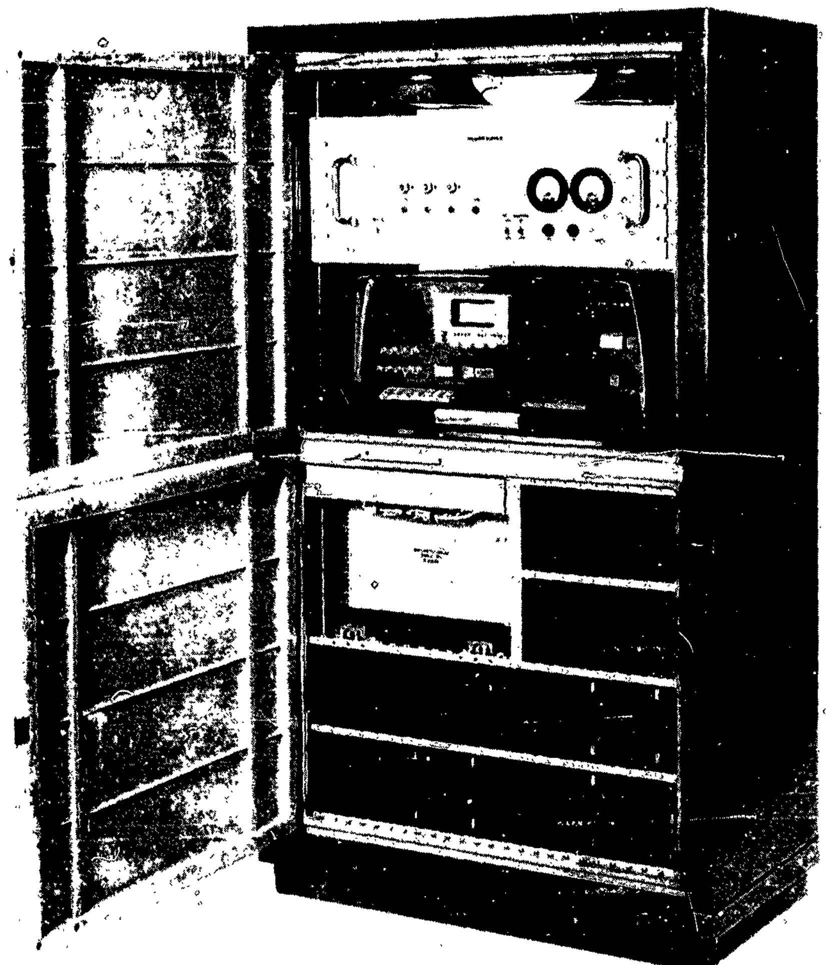


Photo by Leeds and Northrup Company

APPLICATIONS

System is used for industrial process control.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20 + sign bit + parity bit
Binary digits/instruction	6 bits
Instructions per word	1 or 1/2, if 1 + 1 mode
Instructions decoded	16 Basic Up to 64 by use of modifiers
Arithmetic system	Fixed point at extreme left
Instruction type	One address or 1 + 1 by means of programming
Number range	$-1 < n < +1$

Instruction word format

1 8	9 14	15 16	17 20	21
Track Address ($000-255_{10}$)	Sector Address ($000-063_{10}$)	Modi-fier	Instruc-tion	Type: Single or 1 + 1

Automatic built-in subroutines include square root. Programming is done in simple pseudo-code with relative addressing facility.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	910	130
Mult	3,600	2,730
Div	3,600	2,730

Construction (Arithmetic unit only)	Transistors
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	16,260	357,720 bits	Min. - 130 Max. - 16,640

INPUT

Media	Speed
Paper Tape	10 char/sec (Flexowriter)
Analog to Dig Con	5 points/sec (10,000 count ADC)
External counters	50/sec (For integrated measurements, e.g. KWH)
Direct binary inputs	400-600/sec (For reading digital dial and On-Off status of external equipment)

Being a control computer, the design emphasis is on direct inputs from the process under control or analysis.

OUTPUT

Media	Speed
Typewriters	10 char/sec
Flexowriter, punch, IBM electric.	
Digital to Analog Con	6/sec
Stepping motors are used for DAC	
On-Off controls	50/sec
Control state of external equipment.	
Annunciator lights	100/sec

Stepping motors are used for digital to analog conversion, because they have inherent memory.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	3,000
Transistors	1,300

CHECKING FEATURES

Parity bit in each word checks all transfers from drum memory.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.60 Kw	0.65 KVA	0.925 pf
Volume, computer	25 cu ft		
Area, computer	9 sq ft		
Room size	6 x 12 ft		
Weight, computer	400 lbs		

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by the manufacturer to insure required reliability include parity checks, solid state, plug-in components, rugged construction, and extensive checks on input-output equipment.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include powerful command structure, rapid access registers, and memory parity check. Unique system advantages include extensive checks on input-output equipment.

LEPRECHAUN

TRADIC Second Feasibility Computer, LEPRECHAUN

MANUFACTURER

Bell Telephone Laboratories, Incorporated

Photo by Bell Telephone Laboratories, Incorporated

APPLICATIONS

The system was built under a U. S. Air Force contract for programming and logical design research on digital computers for military real-time control applications and as a feasibility model of a direct-coupled transistor logic system and a transistor driven magnetic core storage unit. This solid-state computer features low power and small size. The design emphasizes reliability.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	17, including sign
Binary digits/instruction	17, including two spare bits
Instructions/word	1
Instructions decoded	32
Instructions used	28
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-1 \leq n < 1$

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	40
Mult	375 avg
Div	520

Construction	Transistors
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Concurrent

STORAGE

Medium	Words	Access Microsec
Magnetic Cores	1,024	8

There are 18 bits/word stored, including an "odd" parity bit. The read-write cycle is 20 microseconds.

INPUT

Media	Speed
Paper Tape (Photoelectric)	200 char/sec
Keyboard	Manual

OUTPUT

Media	Speed
Paper Tape (Punch)	60 char/sec
Typewriter	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Crystal diodes	300
Magnetic cores	18,480
Transistors	5,000

The above figures are for the computer proper, and do not include input-output equipment.

CHECKING FEATURES

Odd parity checks on storage and input-output operations.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.160 Kw
Volume, computer	16 cu ft
Weight, computer	450 lbs

Figures are for computer proper and do not include input-output equipment.

PRODUCTION RECORD

Number produced	1
Number in operation	1

This system is a feasibility model and was not designed for production.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

This system has been completed.

ADDITIONAL FEATURES AND REMARKS

LEPRECHAUN features flexibility in the logical interconnections in order to make it useful for logical design research. The operation code has been designed to eliminate the need for many "red-tape" operations. For example, a special unconditional jump operation simplifies the inclusion of subroutines in a program. Address modification is accomplished by direct substitution. This operation, together with a repeat operation, which operates on sequential addresses, gives operation equivalent to a B-box.

The machine contains a manual breakpoint provision, several checking modes of operation and complete marginal checking facilities.

INSTALLATIONS

Bell Telephone Laboratories, Incorporated
Whippany, New Jersey

LGP 30

Librascope General Purpose Computer Model 30

MANUFACTURER

Royal McBee Corporation
Librascope, Incorporated

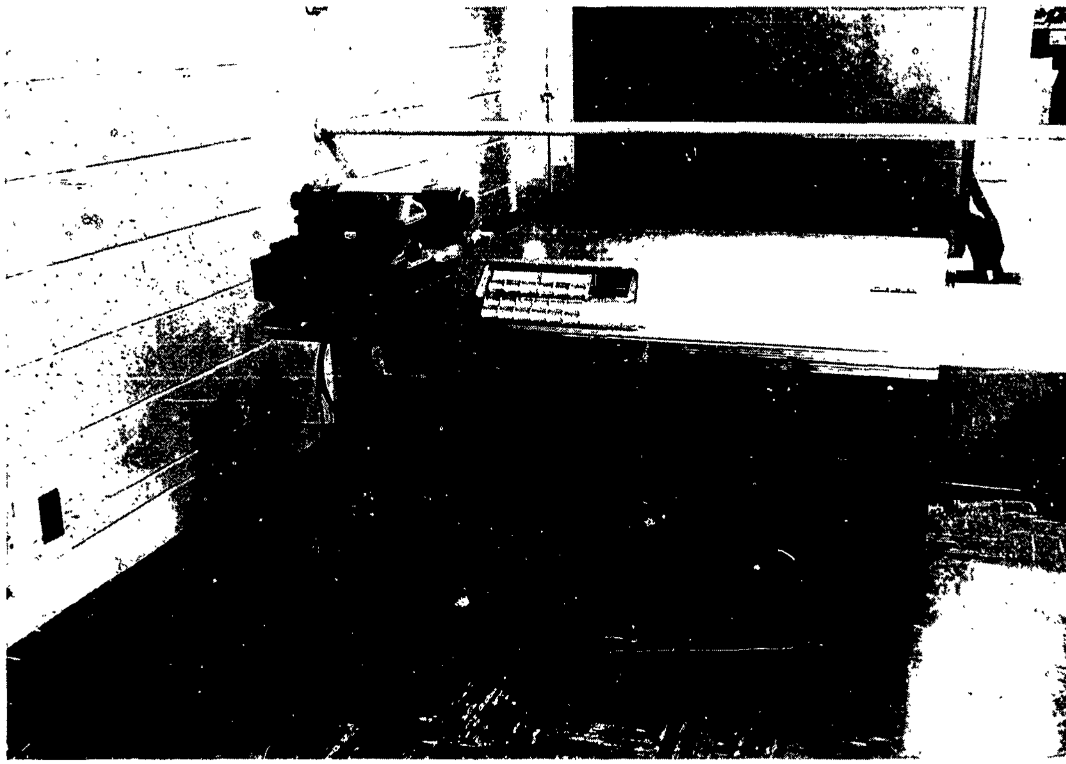


Photo by Flight Simulation Laboratory, WSMR, N. M.

APPLICATIONS

Manufacturer
System is designed for scientific computations, e.g. statistical analysis, operations research, war gaming, bridge and highway design, aeronautical, chemical, electronic, hydraulic, mechanical, mining, nuclear, optical, biological, physical and mathematical research; and data processing, e.g. payroll; cost accounting, distribution and analysis; inventory control; sales analysis.

ADPS Committee, Officers' Dept., USASCS, Ft. Monmouth
System is located in Myer Hall, Room G05, Fort Monmouth, New Jersey. System is used for instruction.

Materials Research Laboratory, Watertown Arsenal, Watertown, Massachusetts
Located at Watertown Arsenal, Watertown, Massachusetts, system is used for numerical integration, least squares curve-fitting, data processing, finite differences, numerical solution of differential equations, algebraic equations (minimization, etc.), and trial and error solution of equations.

U. S. A. Watertown Arsenal Laboratories
Located in Building 39, Watertown Arsenal, computer is used for matrix inversion, numerical integrations of definite integrals and differential equations, diagonalization of matrices, solution of transcendental equations, arising from problems in solid state physics, elasticity, and elastic instability, and thin shell theory.

White Sands Missile Range
Located at the Flight Simulation Laboratory, Building 1526, White Sands Missile Range, New Mexico, the system is used for small problems, mathematical research, and preliminary checkout for problems to be run on large computers.

Pitman-Dunn Laboratories, Frankford Arsenal
Located at Building 202, 3rd Floor, Optical Branch, Fire Control Division, system is used for design of optical systems and components for fire control instruments and related activities.

U. S. Navy Hydrographic Office
Located at FOB No. 3, Room G274B, the system is used for mathematical and statistical studies made of the various parameters of the ocean, primarily in connection with anti-submarine warfare but also in connection with ice forecasting and climatology.

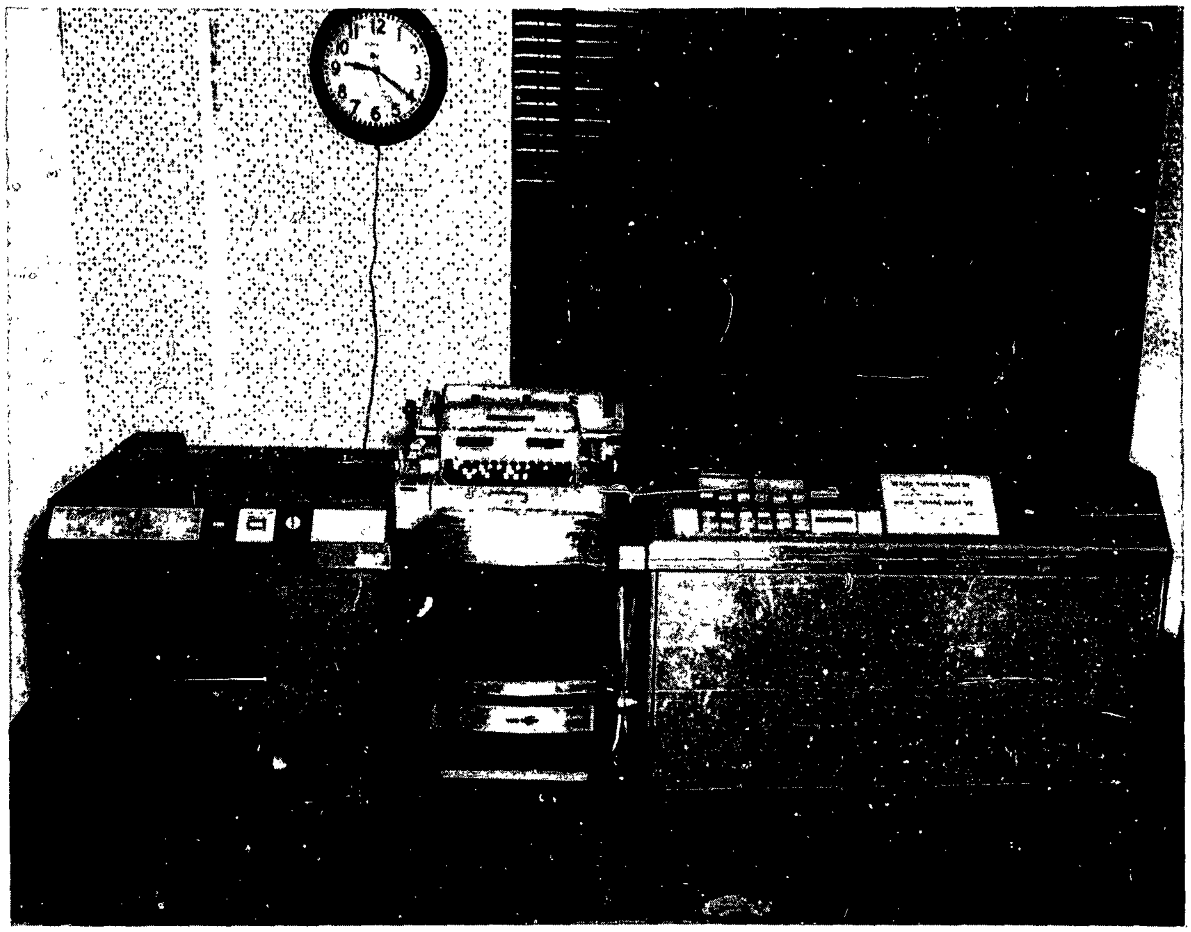


Photo by Tennessee Valley Authority

U. S. Naval Ordnance Test Station, Pasadena
Located at 3202 E. Foothill Blvd., Pasadena, California, system is used for scientific analysis and data reduction.

NASA-Goddard Space Flight Center
One LGP 30 at the Control Center, Greenbelt, Md. and two LGP 30's at Anacostia Naval Station, Wash., D.C., are used for orbital calculations, trajectory analysis, data reduction, and mathematical studies. The organization is responsible for the provision of equipment and services for tracking satellites and probes in nearby portions of space, for obtaining telemetry data from these satellites and probes, and for computing their orbits and providing station predictions, ephemerides and definitive orbits as required by all participating organizations.

Tennessee Valley Authority, Flood Control Branch
Located at the TVA, 718 Union Building, Knoxville, Tennessee, system is used for principally hydrologic and hydraulic computations for watersheds, streams, and reservoirs. Limited use in design computations.

Aircraft Armaments, Inc.
Located at the Systems Engineering Department, Main Engineering Building, system is used for mathematical solutions for research and advanced engineering problems involving differential equations, simultaneous equations (both linear and differential), numerical integrations, n^{th} degree polynomials, exponentials, and trigonometric functions. Some of the applied engineering problems have been concerned with interior and exterior ballistics, trajectories (projectile and rocket sled), probability studies, stress and weight analyses, etc.

ACF Electronics Division
Located at 11 Park Place, Paramus, New Jersey, system is used for optical design (ray tracing), vibration studies (railroad train coupling), integral transforms (Fourier Analysis), navigation, satellite and missile trajectories, reliability studies, reticle design, and miscellaneous "One Time" problems.

Convair-Fort Worth, General Dynamics Corp.
Located at Engineering Flight Test, system is used for editing and calibration of flight test data.

General Electric-Missile and Space Vehicle Dept.
Located at 3198 Chestnut Street, Philadelphia 4, Pa., system is used for solution of equations in flight test data reduction; engineering computations, including aerodynamics, flight mechanics, space science, mechanics problems, and trajectory analysis.

The Griscom-Russell Company
Located at Massillon, Ohio, two systems are used for functional design of heat exchangers and general engineering calculations.

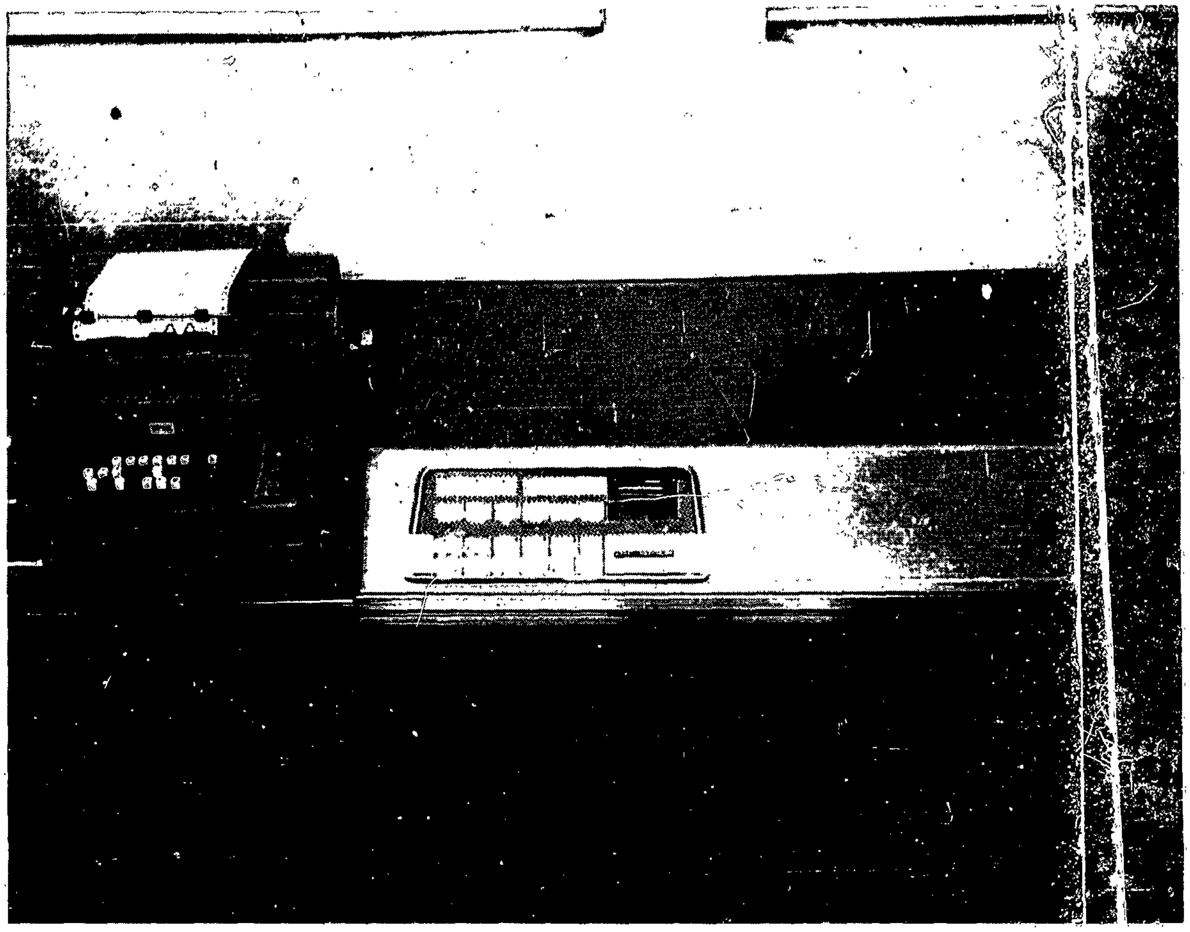


Photo by Aircraft Armaments, Inc.

Mutual Insurance Advisory Association
Located at 111 Fourth Avenue, New York 3, New York, system is used for actuarial and statistical work in connection with casualty insurance ratemaking. This type of work involves relatively small input used for numerous algebraic calculations.

Raytheon Company-Missile Systems Division
Located in the Aerophysics Design Department, system is used to obtain solutions to scientific problems in the fields of aerodynamics, structures, and system analysis, which would not be economical on larger systems.

Research Division, Servomechanisms, Inc.
Located in Building 114, Santa Barbara Airport, system is used for the mathematical simulation of proposed engineering designs; calculation of special functions arising in particular engineering tasks; laboratory data reduction; and solution of various linear and non-linear equations, many of which cannot be analized by classical methods.

Technical Operations, Inc., Fort Monroe, Virginia
Located at Fort Monroe, Virginia, this computer is used to perform scientific computations in support of operations research and war gaming activities. The LGP 30 has been used extensively to process, reduce and statistically analyse data. A variety of applications to war gaming activities also exist. As examples, artillery, close combat and tank anti-tank assessment are currently carried out for War Games Division, CD, on the computer on either a pre-computed or "on-line" basis.

Western Electric Company, Inc.
At Winston-Salem, North Carolina, there are two such systems in use by this organization. Both are used to monitor the performance of automated production lines for electrical components. These production lines consist of completely automatic, specially designed manufacturing facilities integrated into a production line by automatic transport feed facilities. At strategic points automatic monitoring devices inspect the product and transmit these data through input equipment into the computer. The computer analyzes these data on a statistical basis and if corrective action is needed at any point on the production, the computer decides both the correction and magnitude and achieves control through the output equipment.

Computation Center, Dartmouth College
As a separate department closely associated with the Mathematics Department, physically located in a small room on campus, the system is used to train undergraduates in the use of a computer, as a laboratory adjunct to several courses, especially numerical

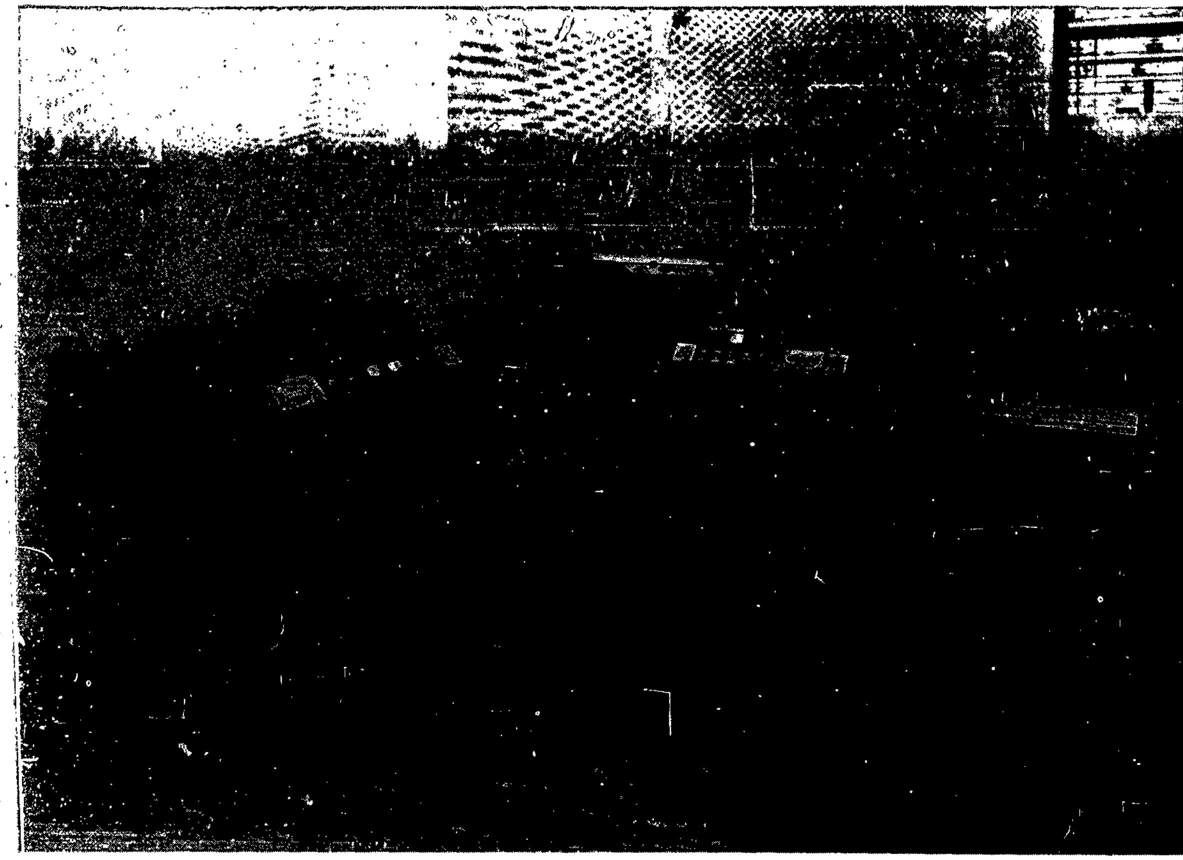


Photo by the Raytheon Company

analysis, as a research tool for faculty and student use, and as a basis for computer oriented research (compilers).

Johns Hopkins University

Located in Room 426 of the Computation Center, Homewood Branch, the system is used for research and teaching in fields of Engineering, Science, Social Relations, Economics, Medicine, Biostatistics and Related Studies.

Lehigh University

Located at the Industrial Engineering Department, Packard Lab, Bethlehem, Pa., the system is used for engineering and scientific analysis and design, statistics and curve fitting, data processing, systems simulation, and classwork in problem-solving.

Missouri School of Mines and Metallurgy

Located at the Computer Center on the campus of the Missouri School of Mines and Metallurgy at Rolla, Missouri, the system is used for research in Engineering and the Sciences by the faculty and graduate students of the Missouri School of Mines and Metallurgy, regular scheduled courses in Numerical Analysis, programming of digital computers and the design of digital computers for both undergraduate and graduate students. A very small amount of time is available for commercial use.

Ohio University

Located in Juper Hall, Ohio University, Athens, Ohio, system is used for teaching and research in atomic and nuclear physics and chemistry.

University of South Carolina

Located at the University of South Carolina, Columbia, South Carolina, system is used for instruction and research.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary
Binary digits/word	32
Binary digits/instruction	32
Instructions/word	1
Instructions decoded	16
Arithmetic system	Fixed point
Simulate floating point by programming	
Instruction type	One address
Number range	9 decimal digits - 5 alpha

Instruction word format

	Command		Address	
1 10	11 15	16 17	18 29	30 31

Automatic coding includes compilers, assemblers, and interpretitive systems.
Registers includes an accumulator - double extension, an instruction, a counter, and 4096 memory registers.

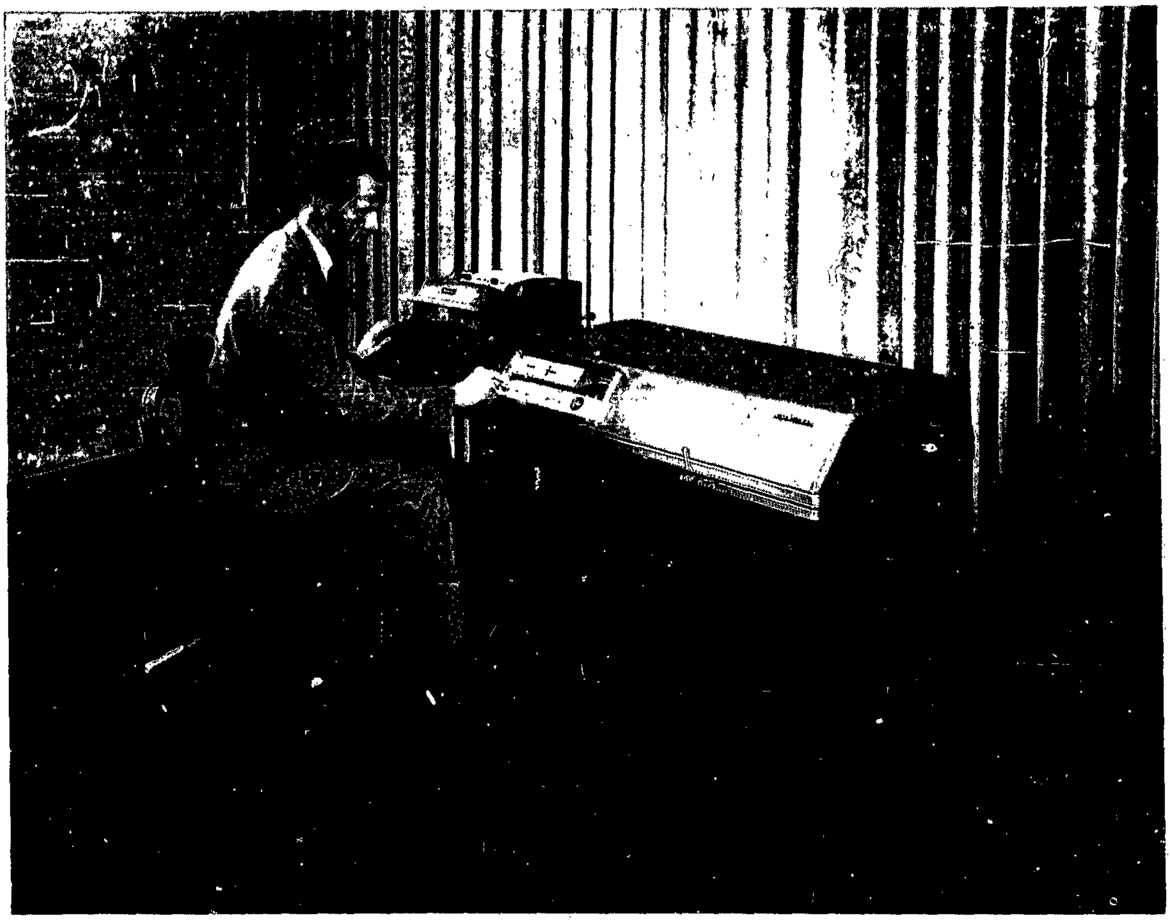


Photo by Servomechanisms, Inc.

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	2,000 - average	250 constant
Mult	17,000	17,000
Div	17,000	17,000

Construction (Arithmetic unit only)	
Vacuum tubes	113
Diodes	1,450
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	4,096	32 binary	Min. 2,000
			Avg. 8,500

A complete instruction can be done in 2200 microseconds, including both accesses when optimum programmed. Maximum operation time is 15,000 microseconds (the time for one revolution of the drum which rotates at 4,000 rpm.

All user's systems have a 4,096 word drum.

INPUT

Manufacturer

Media	Speed
Paper Tape (Photo-electric)	200 char/sec
Paper Tape (Typewriter)	12 char/sec
Cards	20 char/sec

The high speed paper tape reader is for input only and makes possible loading the entire drum: 64 tracks of the LGP 30 in a maximum of five minutes.

The following organizations have the high speed photoelectric paper tape reader:
ADPS Committee, Officers' Dept., USASCS, Ft. Monmouth
Materials Research Laboratory, Watertown Arsenal
U. S. A. Watertown Arsenal Laboratories
Ordnance Mission, White Sands Missile Range
U. S. Navy Hydrographic Office
NASA-Goddard Space Flight Center
Tennessee Valley Authority-Flood Control Branch
The Griscom-Russell Company
Mutual Insurance Advisory Association

Raytheon Company- Missile Systems Division
Technical Operations, Inc., Fort Monroe, Virginia
Johns Hopkins University
Missouri School of Mines and Metallurgy
Ohio University

Western Electric Company, Inc.

Media	Speed
Electronic equipment by Western Electric	140,000/sec. meaningful impulses

Voltage to frequency converter fed into binary frequency counter. Computer scans counter and extracts information. Special data gathering and control equipment designed by Western Electric from on-line production equipment.

Electric Typewriter	10 char/sec

OUTPUT

Manufacturer

Media	Speed
High Speed Punch	30 char/sec
Tape Typewriter Punch	20 char/sec
Tape Typewriter Print	20 char/sec
X-Y Plotter	—

Servomechanisms

Typewriter	10 char/sec
Tape Punch	10 char/sec

Punch causes typewriter to print

Automatic plotting equipment includes a separate tape reader (Friden), a digital analog converter, and a servo plotting board (Mosely Autograph).

W. E.

Electronic equipment designed by Western Electric	140,000/sec. meaningful impulses

Consists of Diode Logic and transistor flip flops actuating binary relays.

Electric Typewriter	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Tubes	113	(Miniature, computer type)
Tube types	7	Primarily 5687, 5965 and 5915
Crystal diodes	1,500	Subminiature

Printed circuits are used extensively.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	1.15 Kw	1.5 KVA
60 cycle single phase line		
Volume, computer		21.8 cu ft
Length, computer		44 in
Height, computer		33 in
Depth, computer		26 in
Area, computer		8.19 sq ft
Room size		5 ft x 5 ft min.
Floor loading		97.7 lbs/sq ft
		800 lbs concen max
Weight, computer		800 lbs

Normal office power is required.

USASCS

No special site preparation requirements other than air conditioning.

MRL Watertown Arsenal

We do have air conditioning, but it is a part of a larger system and was not essential for the operation of computer. However, room temperature should be kept below 97°.

USA WAL

No special preparation necessary.

P-DL FA

Required wiring from existing transformer.

USN Hydro

Essentially the only requirement is access to 115 volt, 60 cycle, single phase, 13 ampere alternating current.

US NOTS

No requirements.

NASA

No requirements.

TVA

No site preparation.

AA

The LGP 30 computer is located in a separate room (9'x10') on the second floor of the main Engineering Building. The building is of masonry construction and the walls of the computer room are dry-wall (plaster board) construction. An exhaust vent, which includes a blower, supplements the internal blower of the computer. The entire building is air-conditioned.

ACF

No site requirements but it would be advantageous to have sound absorbing material on walls and/or ceiling of computer room.

Convair

No site requirements.

GE

No site preparation. 220 VAC power outlet installed.

GR

Direct power line for 2 computers. 7 Tons of air conditioning.

MIAA

No site preparation required for LGP 30 installations. Advised to have separate 110 ckt. for ideal operation.

Raytheon

No site preparation requirements. Suggested minimum 100 sq ft of space.

Servomechanisms

Acoustic tile on portion of one wall; separately fused (breaker) for computer only.

TO, Inc.

Since this computer is desk size and requires no supplementary air conditioning, site preparation and/or modification is minimized. It is necessary to install the computer in an area where sufficient ventilation is provided to exhaust 5,000 BTU/hour dissipated by computer electrical components. In the case of this installation, excess heating of an inside room where the computer was in use made it necessary to install a forced air vent system in the wall. Acoustic tile was also used in the room to reduce the noise level associated with computer operation.

WE

Isolated 110 volt power circuit.

Lehigh University

No site preparation requirements.

MSMM

No site preparation requirements.

Ohio U.

Installed in a room converted from a machine shop- is now a class room.

U of S.C.

No special preparations.

PRODUCTION RECORD

Manufacturer

Number produced to date	462
Number in current operation	450
Number in current production	20
Number on order	38
Anticipated production rates	10 per month
Time required for delivery	1 month

COST, PRICE AND RENTAL RATES

Manufacturer

Cost of basic system

Computer and tape-typewriter	commercial	$49,500
	government	49,300
	educational	29,700

Cost for additional equipment

High speed punch and photo-reader	$ 6,360
Photoelectric reader alone	4,800

Punched card control unit and X-Y plotter purchased by special arrangement.

Rental for basic system

$1,100/month, commercial and government, $880 educational.

Rental rates for additional equipment

Punch and reader	$265/mo
X-Y plotter	300/mo
Card input unit	100/mo
Photo-reader	200/mo

Maintenance included in rental; service contract available for purchasers.

USASCS

Cost of basic system is $43,500 for the LGP and Flexowriter, and $4,800 for the tape reader.

Maintenance service contract cost $1,750/annum, without parts.

USA WAL

$1,500 per month for computer, photo-reader and extra tape typewriter.

WSMR

LGP 30 and Flexowriter rent for $1,100 per month. Paper tape reader rents for $200 per month. Additional Flexowriter rents for $150 per month.

GR

Two LGP 30s rent for $1,100 each, total $2,200/month.

Flexowriter		$150/mo
Photo-reader		200/mo
Punch		65/mo
	Total	$415/mo

Servomechanisms

LGP 30 with paper tape reader, punch, Friden Typewriter cost $50,000.

Tape reader, digital to analog converter, servo plotting board cost $4,000.

No contract at present; service labor rate is $12.50 per hour.

TO, Inc.

LGP 30 Computer with typewriter rents for $1,150/mo. High speed reader-punch and auxiliary typewriter rents for $365/mo.

"On-call" servicing from Washington, D. C. ($50 service charge).

WE

$70,000 total cost (includes special input and output).

Dartmouth

LGP 30 with attached Flexowriter, extra Flexowriter, and photoreader about $37,000, school cost.

About $2,500 per year, plus parts, plus travel over fifty miles.

Lehigh U.

Cost of basic system

Computer	$49,500

Cost of additional equipment

Photo-reader and punch	6,360

Maintenance service contract is $2,500/year.

MSMM

1 Royal McBee LGP 30 Computer $29,700

1 Royal McBee Model 342 High Speed Paper Tape Reader and Punch, 1 Off-line tape typewriter (Flexowriter); grant from Royal McBee Corp.

None first year. All addition years will be $4,500 per year including all parts and service for entire system.

PERSONNEL REQUIREMENTS

Manufacturer

Requirements among users will vary widely. Many existing LGP 30 installations are staffed by one programmer and one tape punch operator; others, by one person performing all functions; others, by one person for each function. No maintenance or other technical personnel are required by the user.

Manufacturer trains by programming schools for users (no cost), maintenance schools for users, if desired ($600 per person), and local assistance by applications analysts (no cost).

USASCS

	One 8-Hour Shift
Programmers	5-25
Operators	1

Training is at no cost to the government. Any engr, math, or phy can be taught in 2 weeks. Maintenance course, 5 weeks at $500/person.

MRL Watertown Arsenal

In general the machine runs about 42 hours a week. Six persons from three separate organizations (all located at Watertown Arsenal) use the machine and do their own programming, operating, and preparation of tapes. The operation of the computer is a part time job for all six persons, most of whom are mathematicians.

Operation tends toward open shop.

Twelve hour course given on site by Royal McBee personnel. Also programming school (two weeks course) is available through Royal McBee Corporation, free of charge.

USA WAL

	One 8-Hour Shift
Supervisors	2
Programmers	5

Operation tends toward closed shop.

Courses were given by Royal McBee Corporation.

Occasional two or three-shift operation is necessary, but not enough to warrant hiring extra people.

P-DL FA

The computer is programmed and operated by six individuals engaged in optical design activity with an estimated total time equivalent to that of one full time employee. The majority of programs covering optical ray trace methods and related activities have been provided by the Royal McBee Corporation.

The modifications required to adopt these programs for our particular needs have been completed. Minor modifications to these programs and new programs which are relatively short are developed by optical

personnel.

Any future modifications of a lengthy nature or extensive programs for automatic lens design would be performed by either the mathematics section or by contract. Total cost estimated for this activity would be equivalent to that of using one employee on a half time basis.

Operation tends toward closed shop.

Personnel attended a two week training course offered by Royal McBee's New York office.

TVA

The LGP 30 is used by a staff of approximately 25 engineers as needed. One of the staff engineers acts as supervisor or coordinator of machine activities. This supervision requires approximately 20% of his time.

The number of engineers using the LGP 30 is continually increasing.

Scheduling and time keeping is on an informal basis.

Operation tends toward open shop.

Approximately 40 people were trained by a Royal McBee instructor when the computer was installed. Approximately 20 people have been trained by in-service training and self study. Approximately 35 people were trained recently in a TVA sponsored after hours training class. Other classes will be held as the need arises.

AA

One programmer/operator is required normally, but two often are employed under high computer work load conditions. The computer is used on one standard 8-hour shift (40-hour week) and is in operation approximately 60% of the time.

Operation tends toward open shop.

No formal methods of training have been introduced as of this time. Lectures on programming and operation of the computer have been given to various company personnel and will be continued.

Convair

Complete open shop, no personnel uniquely assigned.

GE

	One 8-Hour Shift
Supervisors	1
Analysts	6
Programmers	6
Coders	5
Operators	1
Engineers	4
Technicians	1

Operation tends toward open shop.

On-the-job training used.

Raytheon

At the present time, there are eight (8) mathematicians and engineers from two (2) departments using this system, for which one person is responsible.

Servomechanisms

	One 8-Hour Shift	
	Used	Recommended
Supervisors	.1	.1
Analysts	.1	.2
Programmers	.4	.7
Clerks	.1	.2
Operators	.5	.7

Operation tends toward open shop.

Company sponsored classes open to all advanced engineering employees, (usually 2 hours per day for one week, each year).

TO, Inc.

The simplicity of LGP 30 operation makes it feasible to train most analysts to use computational facilities, whenever a problem is encountered suitable for computer solution. For the most part the analyst will program, code, and "debug" his own particular problem. In those cases where problems will involve more detailed programming or extensive coding and "debugging", programmer-coders are available to assume responsibility for the problem. This open shop operation is tailored to the requirements of this organization and has, thus far, proved to be quite efficient.

Operation tends toward open shop.

Two procedures have been used at this installation. These are 1. attendance at a two week LGP 30 programming course and 2. on-the-job training supervised by experienced personnel. Option 2 is generally used in those cases where analysts or programmers have prior computer experience.

Dartmouth

One machine supervisor is used. All our programming is done by students. About 10 of them keep the machine busy all week one full shift by putting in about 6 hours apiece.

Operation tends toward open shop.

Training is "sink or swim" with help given as needed. We give the students a simple problem, a machine manual, a few words of advice and let them work on their own. We do not give extensive lectures, but may give one or two hours when computing is part of regular course where the students do not have the time to learn by themselves.

Lehigh U.

	One 8-Hour Shift		Two 8-Hour Shifts	
	Used	Recomm	Used	Recomm
Supervisors	1	1		1
Analysts	1	2		1
Programmers	2	2		
Coders	1	2	1	1
Clerk-Librarian	1	2		1
Operators		1	1	1

Operation tends toward open shop.

Methods of training used includes Compiler (short informal course), Interpreter (short, formal course), Basic Language (intensive course with extensive, informal practice) and Operation (intensive course with extensive, informal practice). Plan to teach operation with special "Automated Program".

MSMM

1 supervisor 2/3 time - recommended 1 full time
1 combination programmer and operator - recommended 2
1 combination coder and clerk - recommended 2

Operation tends toward open shop.

Regular scheduled university courses in Numerical Analysis, Programming, and operation of the computer. Occasionally short courses in programming and operation are taught.

Ohio U.

A course (1 semester, 3 hour credit) is offered in the Mathematics Department.

Operation tends toward open shop.

U of S. C.

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	1

Operation tends toward open shop.

Individual instruction to students.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Operating ratio (Good/Attempted to run time) 0.95

Figure based on user performance records.

MRL Watertown Arsenal
Good time 39 Hours/Week (Average)
Attempted to run time 42 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.93
Above figures based on period from May '59 to May 60
Time is not available for rent to outside organizations.

USA WAL
Good time 21 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period 27 Sep 59 to 12 Dec 59
Passed Customer Acceptance Test 5 May 59
Time is not available for rent to outside organizations.

WSMR
Good time 39.5 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.99
Above figures based on period from Jun 58 to Apr 60
Passed Customer Acceptance Test Jun 58
Time is not available for rent to outside organizations.

P-DL FA
Good time 34.2 Hours/Week (Average)
Attempted to run time 37.4 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.932
Above figures based on period from Nov 59 to Apr 60
Passed Customer Acceptance Test Apr 59
Time is not available for rent to outside organizations.

USN Hydro
Good time 36 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 1 Apr 59 to 20 Apr 60
Passed Customer Acceptance Test Apr 59
Time is not available for rent to outside organizations.

US NOTS
Good time 25 Hours/Week (Average)
Attempted to run time 29 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.86
Above figures based on period 1 Dec 59 to 1 May 60
Passed Customer Acceptance Test Nov 59
Time is not available for rent to outside organizations.
This is a small computer but it is capable of handling a large number of general engineering and scientific problems. It presently complements an IBM 709 located at the Naval Ordnance Test Station at China Lake, Calif.

NASA
Good time 23.0; 36.0; 25.7 Hours/Week (Average)
Attempted to run time 33.4; 38.9; 34.2 Hours/Week
Operating ratio 0.689; 0.925; 0.751
Above figures based on period from 1 Feb to 10 Apr
Time is not available for rent to outside organizations.

TVA
Good time 36 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period from Dec 57 to May 60
Passed Customer Acceptance Test Dec 57
Time is not available for rent to outside organizations.
Down time varies considerably. There was one six month period of no down time. Service men come from out of town, so down time is largely travel time of the service man.

AA
Good time 24 Hours/Week (Average)
Attempted to run time 25 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Oct 59 to Apr 60
Time is available for rent to outside organizations.
The LGP 30 has been a very reliable computer with little or no down time except for periodic preventive maintenance checks. The Flexowriter (standard input-output unit) has given only those minor difficulties usually encountered with typewriters.

ACF
Good time 24 Hours/Week (Average)
Attempted to run time 30 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.80
Above figures based on period from Jul 59 to Jul 60
Time is available for rent to qualified outside organizations.

Convair
Good time 40 Hours/Week (Average)
Attempted to run time 44 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.91
Above figures based on period 1 Jan 59 to 31 Dec 59
Passed Customer Acceptance Test 1 May 58
Time is available for rent to outside organizations.

GE
Average error-free running period 34 Hours
Good time 34 Hours/Week (Average)
Attempted to run time 35 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period from Jan 60 to Aug 60
Passed Customer Acceptance Test Jan 60
Time is not available for rent to outside organizations.

GR
Average error-free running period 190 Hours
Good time 37.3 Hours/Week (Average)
Attempted to run time 41.2 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.905
Above figures based on period 1 Jan 60 to 30 Mar 60
Time is not available for rent to outside organizations.
1st LGP 30 installed Aug 57 and replaced Mar 59.
2nd LGP 30 installed Mar 59

Raytheon
Good time 28 Hours/Week (Average)
Attempted to run time 32 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period from May 60 to Aug 60
Passed Customer Acceptance Test Aug 58
Time is not available for rent to outside organizations.
Since the operating costs of this machine are extremely inexpensive, since this system is open shop not emphasizing programming skills, and since long production runs are left running unattended all night, we do not try to schedule work to obtain 100% utilization during regular working hours; however, it is utilized at least 70% of this time with as much all night productions as necessary. It is not uncommon to have the machine running 24 continuous error-free hours.

Servomechanisms
Average error-free running period 6 - 7 Weeks
Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period Apr 59 to 26 Apr 60
Passed Customer Acceptance Test May 58
Time is available for rent to qualified outside organizations.

TO, Inc.
Average error-free running period 2 Months
Good time 34.3 Hours/Week (Average)
Attempted to run time 35.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98

Above figures based on period 25 Feb 59 to 25 Apr 60
Passed Customer Acceptance Test 24 Feb 59
Time is not available for rent to outside organizations.
Excellent reliability since installation. Hours/week running time is approaching full single shift operation as computational requirements continue to increase.

WE

Average error-free running period	360 Hours
Good time	35 Hours/Week (Average)
Attempted to run time	40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.875

Above figures based on period from Dec 58 to Jul 60
Passed Customer Acceptance Test 18 Dec 57
Time is not available for rent to outside organizations.

Dartmouth

Good time	One week (Average)
Operating ratio	0.90

Above figures based on period 1 Jun 59 to 12 Apr 60
Time is not available for rent to outside organizations.
We have about one breakdown every two weeks. We will then remain down for about two days since the repairman must make it a days trip from Boston.

JHU

Average error-free running period	1 Week
Good time	35 Hours/Week (Average)
Attempted to run time	40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.875

Above figures based on period from Feb 60 to Sep 60
Time is not available for rent to outside organizations.
General performance of computer has been good. Flexowriter input-output unit has been responsible for most of the computer down time.

Lehigh U

Good time	36 Hours/Week (Average)
Attempted to run time	37 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.97

Above figures based on period 1 Jun 59 to 31 May 60
Passed Customer Acceptance Test 1 Dec 57
Time is available for rent to qualified outside organizations.

Ohio U

Good time	40 Hours/Week (Average)
Attempted to run time	40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.95

Above figures based on period from 58 to 60
Passed Customer Acceptance Test 1957
Time is available for rent to qualified outside organizations.
Open shop - we keep no records of who uses it, when, or what for.

U of S.C.

Good time	60 Hours/Week (Average)
Attempted to run time	60 Hours/Week (Average)

Above figures based on period from Jun 59 to Apr 60
Passed Customer Acceptance Test Jun 59
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include low cost; compactness; ease of programming; large users' organization with well-stocked program library; alphanumeric input-output including full format control; large memory; no special installation requirements; nation-wide maintenance and service network.

MRL Watertown Arsenal

Outstanding features include an internally stored program; large memory; flexibility with input, output; no special site preparation; relatively simple programming. Several compilers are available for the LGP 30, interpretive systems in floating point are extremely useful, and almost all of our work is done in floating point and there are a large number of subroutines available.

WSMR

Outstanding features include high reliability and simple programming.

USN Hydro

Outstanding features include compactness, low heat dissipation, and reasonable rental.

TVA

Outstanding features include simplicity of programming and operation and a practical manual input. Good machine for informal, open shop operation. The computer serves present needs very well. However, service from out of town is inconvenient and wasteful of time.

AA

Compact, desk-sized, completely mobile. Speed equal to many room-sized computers. Plugs into any regular wall outlet (110V). Compared to computers in its class, the LGP 30 has the largest capacity (4096 words) for data and program. Paper program tapes and data tapes are labeled on the Flexowriter and stored in circular containers which are likewise labeled. These tape containers are stored in a metal cabinet with other computer literature and programming forms.

ACF

Outstanding features include ease of programming and large memory for machine of this price.

GE

Outstanding features include ease of programming, small size and sufficient speed.

Raytheon

Outstanding features include low cost computations, simplicity in programming and operating, and may be used as a desk calculator.

Servomechanisms

Outstanding features include ease of programming and operating.

TO, Inc.

Outstanding features: This is a simple computer to program and operate. 4,000 words of fast access storage make this computer competitive with others renting for substantially higher rates. Input is easily accomplished using typewriter or tape input. Specific storage locations can be interrogated. Programming and "debugging" is simplified through the use of a single operation option which allows the coder to step through a program instruction by instruction. System is limited to paper tape input-output, 16 basic orders in fixed point operation, 1 logical order, one address, lack of MQ register makes double precision computation difficult, relatively slow, stops on accumulator overflow, and the requirement for "spacer bit" complicates programming.

WE

Outstanding feature is its simplicity of programming.

Dartmouth

System is small and inexpensive, binary, homogeneous memory, able to do logical operations on symbols easily.

Ohio U

Outstanding feature is its ease of use.

U of S.C.

This LGP 30 is extremely reliable except for some Flexowriter troubles.

FUTURE PLANS

Manufacturer

Production of basic system to continue with electronic improvements as developed.

MRL Watertown Arsenal

Present plans indicate renting a larger small scale computer to replace the LGP 30. The RPC 4000 is the latest machine developed by Royal Precision Corporation and has double the memory, double the number of instruction of the LGP 30, is fully transistorized and is much faster. Our computing needs demand the larger machine now.

USA WAL

It is possible that the present system will be replaced by the slightly larger and faster RPC 4000 at an undeterminate future date, but nothing definite has gotten underway on this.

P-DL FA

Contract with University of Rochester to develop a program for automatic lens design.

US NOTS

It is proposed to install a Digital Equipment Corporation PDP-3 Computer in the Simulation and Computer Center at NOTS, Pasadena. This would be a medium size (16K) very high speed computer which will be used for real time, physical, and computed simulation problems, in conjunction with the existing analog facility of over 600 amplifiers.

Convair

The function of the LGP 30 is being absorbed by the IBM 704. The LGP 30 will be eliminated.

GE

It is anticipated that one additional LGP 30 will be put into service.

TO, Inc.

The increased computational requirements of this organization during the past year, specifically in support of war gaming activity is indicative of a trend which will continue. A concentrated effort is being made to relieve the war gamer of the computational burden associated with combat assessment and thus improve and accelerate war gaming activity. This gradual automation of war game control functions is currently taxing our computational facilities. It is apparent that in the near future these facilities must be expanded.

No specific system has been selected at this time, however, we are currently surveying the computer field in an effort to determine which is the system best tailored to our future needs.

Dartmouth

We plan to move in about a year to more suitable quarters. The Center will then consist of the machine room 20 by 30, an adjoining work 12 by 16, a store room 6 by 10. This room will be equipped efficiently for student and open shop operation. We have no plans at present for new equipment, though we would naturally want to keep approximately up to date as new developments are made.

MSMM

Plans for the immediate future include the purchase of an extra tape typewriter, card input-output equipment and high accuracy analog computer equipment. Future plans also include the purchase of another digital computer with considerable more speed and capacity then the present LGP 30 computer system. All of this equipment to be installed in the Campus Computer Center.

U of S.C.

It is anticipated that a photoreader for the LGP 30 will be added.

INSTALLATIONS

ADPS Committee, Officers' Department, USASCS
Fort Monmouth, New Jersey

Materials Research Laboratory
Watertown Arsenal
Watertown, Massachusetts

Watertown Arsenal Laboratories
Watertown 72, Massachusetts

Ordnance Mission
White Sands Missile Range, New Mexico

Pitman-Dunn Laboratories, Frankford Arsenal
Philadelphia 37, Pennsylvania

U. S. Navy Hydrographic Office
Washington 25, D. C.

U. S. Naval Ordnance Test Station, Pasadena
3202 E. Foothill Blvd.
Pasadena, California

NASA - Goddard Space Flight Center
c/o Anacostia Naval Station
Washington 25, D. C.

Tennessee Valley Authority, Flood Control Branch
712 Union Building
Knoxville, Tennessee

Aircraft Armaments, Inc.
Cockeysville, Maryland

ACF Electronics Division
11 Park Place
Paramus, New Jersey

Convair-Fort Worth
Division of General Dynamics Corp.
Fort Worth, Texas

General Electric-Missile and Space Vehicle Dept.
3198 Chestnut Street
Philadelphia 4, Pennsylvania

The Griscom-Russell Company
Massillon, Ohio

Mutual Insurance Advisory Association
111 Fourth Avenue
New York 3, N. Y.

Raytheon Company
Missile Systems Division
Bedford, Massachusetts

Research Division, Servomechanisms, Inc.
Building 114, Santa Barbara Airport
Goleta, California

Technical Operations, Inc.
Fort Monroe, Virginia

Western Electric Company, Inc.
3300 Lexington Road, S. E.
Winston-Salem, North Carolina

Dartmouth College, Computation Center
Hanover, New Hampshire

Johns Hopkins University
34th and Charles Streets
Baltimore 18, Maryland

Lehigh University
Bethlehem, Pennsylvania

Missouri School of Mines and Metallurgy
Rolla, Missouri

Ohio University
Athens, Ohio

University of South Carolina
Columbia, South Carolina

LIBRASCOPE 407

Librascope 407

MANUFACTURER

General Precision, Inc.
Librascope Division

APPLICATIONS

General purpose, airborne, guidance and navigational computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number binary digits/word	22
Number binary digits/instruction	44
Number instructions per word	1
Arithmetic system	Fixed point
Instruction type	Four address
Instruction word format	

Current Instruction				
α_s	α_t	β_s	β_t	Oper

Next Instruction				
γ_s	γ_t	δ_s	δ_t	Oper

Operands are α, β, and γ

Next instruction is δ

System includes 2 accumulators, 1 multiplicand, 1 multiplier register, and 2 instruction registers.

ARITHMETIC UNIT

	Exclud. Stor. Access Microsec
Add	100
Mult	2000
Div	4000

Construction (Arithmetic unit only)

Transistors	500
Resistor-Diodes	5000
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Binary Digits
Drum	3000	66,000

INPUT

Media
Pulse
Analog-Digital
Key Punch

OUTPUT

Medium
Digital-Analog

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.25 Kw
Volume, computer	0.9 cu ft
Weight, computer	56 lbs

INSTALLATIONS

General Precision, Inc.
Librascope Division
808 Western Avenue
Glendale, California

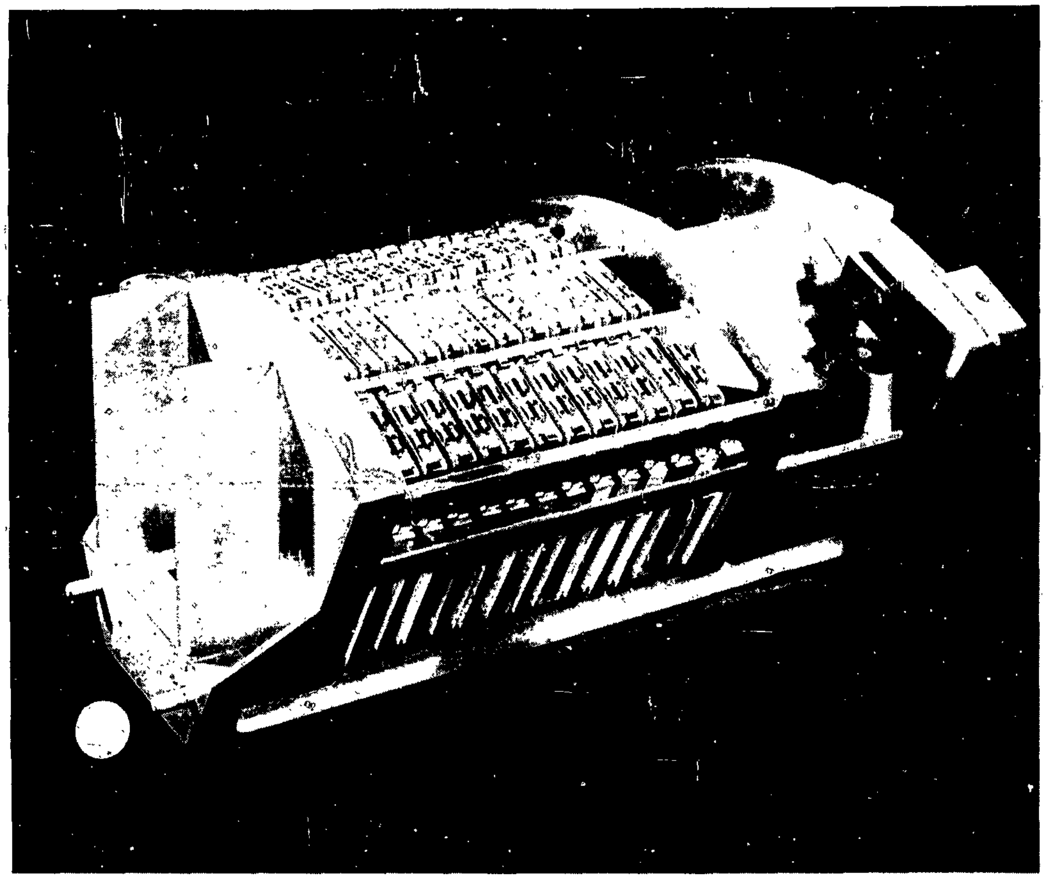


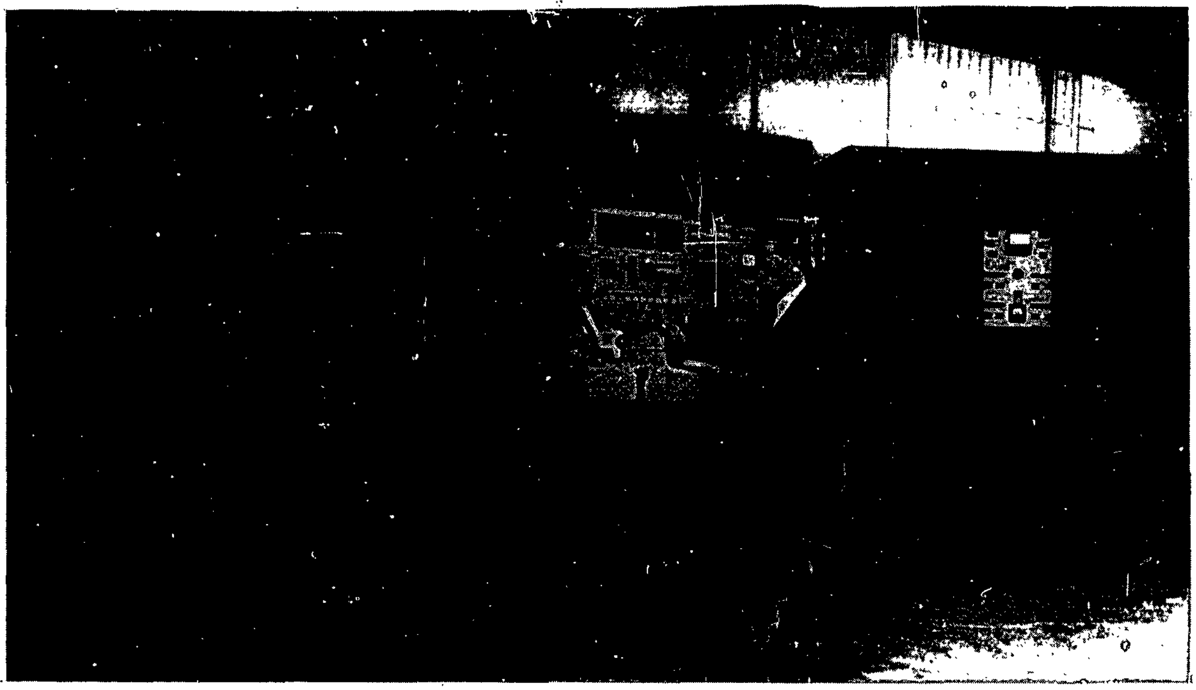
Photo by Librascope Division, General Precision Corporation

LIBRASCOPE AIR TRAFFIC

Librascope Air Traffic Control Central Data Processor (ATC)

MANUFACTURER

Librascope Division
General Precision, Incorporated



Maddocks Photo for Librascope Division, GP, Inc.

APPLICATIONS

System meets general purpose data processing requirements where high speed, large capacity random inquiry files are required and large numbers of different types of input-output systems are connected. Specifically, it is designed for on-line, real time use in the control of air traffic. Some functions are those of flight plan breakdown, conflict prediction, conflict resolution, flow prediction, flight strip preparation and updating, flight plan updating, etc.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Binary coded decimal digits/word	8
Binary coded decimal digits/ instruction	8
Instructions per word	1 (includes field specification)
Instructions decoded	31
Arithmetic system	Fixed point (Magnitude plus sign)
Instruction type	One address

Instruction word format

-	C	X	Y	M	M	M	M
Not used	Command	Field Specif		Operand Address			

Automatic built-in subroutines include an error mode, entered by detection of an error. It interrupts program, stores instruction address, and R register contents.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec	
Add	32	22	Max.
Mult	366	356	Av.
Div	380	370	Av.

Construction (Arithmetic unit only)	
Transistors	3,000
Arithmetic mode	Serio-parallel
Timing	Synchronous
Operation	Serial by alphanumeric character Parallel by bit

Maddocks Photo for Librascope Division, GP, Inc.

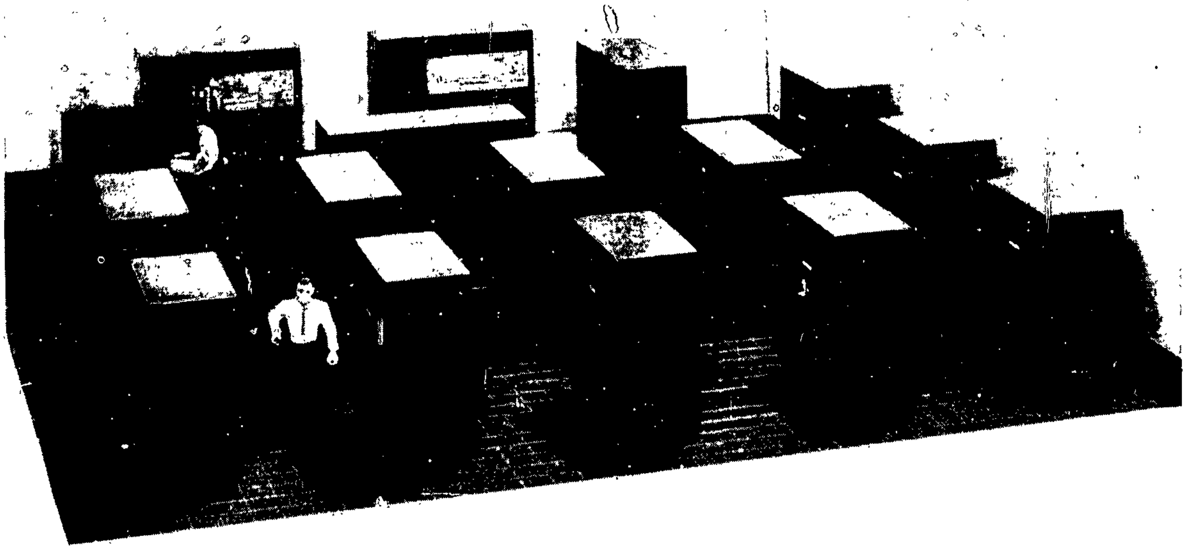
STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Core Memory	4,000	32,000	10
Magnetic drum	256,000	2,032,000	16,000
Magnetic tape	Multiple FR 300 units		

No. of units that can be connected	32	Units
No. of characters/linear inch	200	Chars/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating each record	1/2	Inch
Tape speed	75-150	Inches/sec
Transfer rate	30,000	Chars/sec
Start time	3	Millisec
Stop time	3	Millisec
Physical properties of tape		
Width	1/2	Inches
Length of reel	2,400	Feet
Composition	Oxide on paper or plastic	

INPUT

Media	Speed	No. of Multi-plexed Channels
Flexowriter	10 char/sec	
Photo Reader	330 char/sec	
Teletype via buffer	10 char/sec	12
Keyboard via display console	15,000-20,000 ch/s	30
Data Link	50 char/sec	4
Analog-Digital Conv from Radar	50 char/sec	2
Inter Computer via Buffer	200,000 ch/s	1



Maddocks Photo for Librascope Division, GP, Inc.

OUTPUT

Media	Speed	No. of Multiplexed Channels
Flexowriter	10 chars/sec	
Teletype via Buffer	10 char/sec	7
Charactron via display console	15,000-20,000 ch/s	30
Flight strip via display console	15,000-20,000 ch/s	30
Flight strip punch and printer	10 char/sec	12
Data Link	30 char/sec	7
Analog-Digital conv to radar trackers	30 char/sec	2
Inter Computer via buffer	200,000 char/sec	1

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

(For a minimum system)

Type	Quantity
Tubes	0
Diodes	
About 5 types	1,500
Transistors	23,000
2N393	
2N599	
2N416	
2N498	
2N404	
2N595	
and a few others	

CHECKING FEATURES

Checking features include parity on all registers, and all information exchanges between units. A dual adder is used in the arithmetic unit. Complete checking is performed.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	3 Kw
Power, air conditioner	2 Kw
Volume, computer	140 cu ft
Area, computer	23 sq ft
Floor loading	20 lbs/sq ft
Air conditioner is internal	
Weight, computer	3,000 lbs
Air conditioner is included in above	

PRODUCTION RECORD

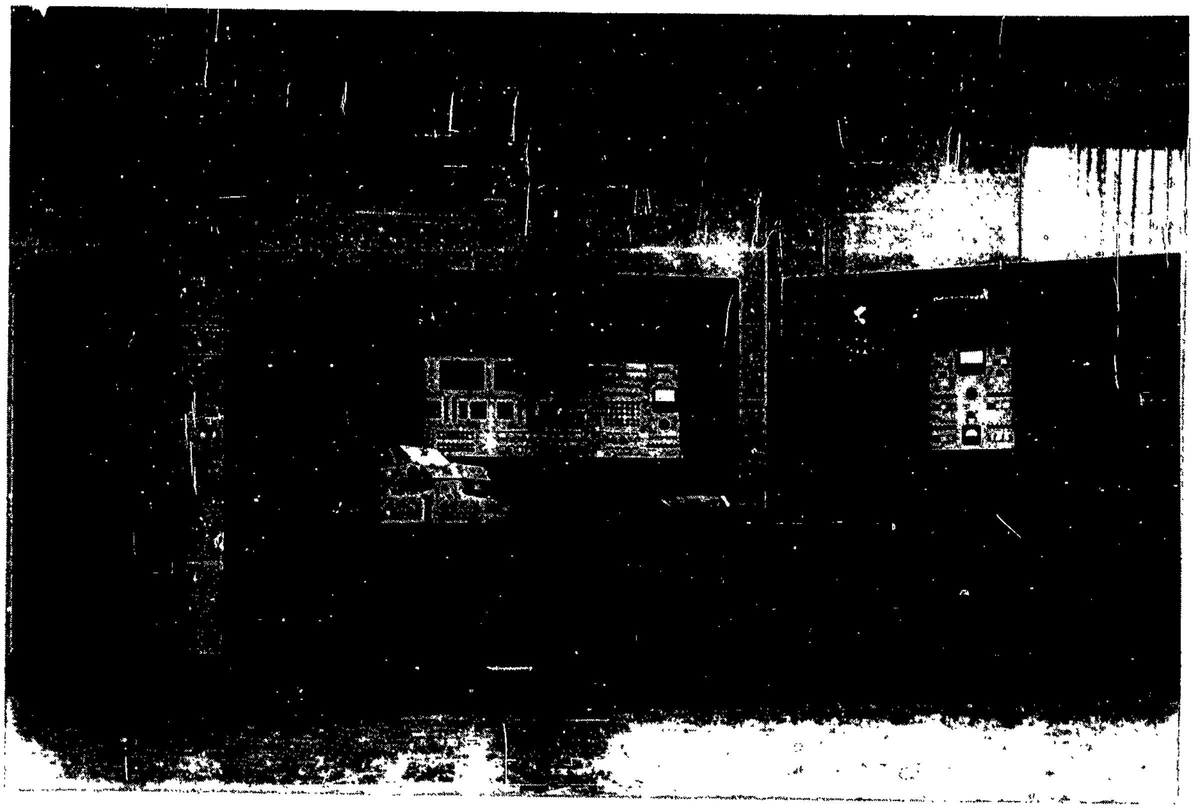
Number produced to date	2
Number in current operation	1
Number in current production	2
Time required for delivery	12 months

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Construction techniques utilized to insure reliability includes "NOR" circuitry, RTL logic, 100% incoming inspection, rigid testing, "worse, worse" case type of design, extensive field reports on failures plus immediate corrective action, and the use of double rank registers.

ADDITIONAL FEATURES AND REMARKS

System is particularly suited to systems requiring random retrieval from large unsorted files and systems with large numbers of input-output devices.



Maddocks Photo for Librascope Division, GP, Inc.

FUTURE PLANS

It is planned to change to a 6 microsecond memory cycle time and increase the pulse rate, which will reduce the operation times by a factor of 4. Also, index registers will be added and the drum capacity will be increased.

INSTALLATIONS

Librascope Division of General Precision, Inc.
808 Western Avenue
Glendale 1, California

LIBRASCOPE ASN 24

Librascope ASN 24 Airborne Digital Computer

MANUFACTURER

Librascope Division
General Precision, Incorporated

Photo by Librascope Division, GP, Inc.

APPLICATIONS

The ASN-24 Computer is a highly versatile general-purpose electronic digital computer which by virtue of its non-fixed internally-stored program, is easily adaptable to many commercial, scientific and military uses. In addition, its small size and weight and low power requirements make it particularly well suited for application in compact systems.

While the ASN-24 Computer can be utilized for extensive on-line general purpose computing applications, it has been designed primarily to satisfy the complex environmental and operational performance requirements of airborne/spaceborne systems real-time applications. The computations may be made from doppler derived ground speed, manually fed fixes, true heading, celestial position determination, and radio aids. Automatic inputs of the following form may be accepted. (When utilized with appropriate complementing input-output equipment):

Compass heading
Astro compass heading
True air speed
Doppler ground speed and drift angle
Inertial velocity
Radio aids
TACAN range and bearing
Automatic sextant (Celestial altitude and azimuth)
Altitude above terrain or above sea level
An internal standard for both sideral and solar time
Star tracker
New equipment as it is developed

Information may also be fed into the computer manually. Manually stored information may be latitude, longitude, range, bearing, wind force or angle, or any direct fix data not available from the aircraft's instrument.

Basic data necessary for navigation may be set manually into the computer before take-off, or in the air.

The ASN-24 will perform the following basic computations as well as solve other desired navigational problems:

Ground position in latitude and longitude with computing errors not to exceed 0.01% of distance traveled.

Ground track

Polar navigation

Great circle course and distance to alternate destinations

Magnetic variation and true heading

Wind direction and velocity (and has provision for wind memory)

Celestial fixes

Position from radar or radio aids (and will check these fixes for credibility)

Range and bearing to a moving target

Range and bearing to a collision point with a moving target

Time to destination

Altitude and azimuth of a celestial body

Image motion compensation and timing for aerial photography

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	25
Binary digits/instruction	25
Instructions/word	1
Instructions decoded	not applicable
Arithmetic system	Fixed point
Instruction type	Two-address (One-plus-one)

The "one-plus-one" addresses are of the operand and the next instruction.

Number range -1 to $+1 - 2^{-24}$

Instruction word format

$P_{24}P_{23}P_{22}P_{21}P_{20}$	$P_{19}P_{18}P_{17}P_{16}P_{15}$	$P_{14}P_{13}P_{12}P_{11}P_{10}P_{9}$	$P_{8}P_{7}P_{6}P_{5}P_{4}P_{3}$	$P_{2}P_{1}P_{0}$
T_α	T_β	S_β	S_α	O

T_α (P_{24} - P_{20}) represents the track address of the next instruction

T_β (P_{19} - P_{15}) represents the track address of the operand (except for transfer and store orders)

S_β (P_{14} - P_9) represents the sector address of the operand (except for transfer and store orders)

S_α (P_8 - P_3) represents the sector address of the next instruction

O (P_2 - P_0) represents the order to be performed

Transfer Orders: (T_β, S_β) represents the track and sector addresses of the next instruction if the contents of the accumulator is positive

Store Orders: (T_β, S_β) defines the location into which the contents of the accumulator is stored, or defines the modified store order to be performed

Automatic built-in subroutines include Add, Subtract, Multiply, Divide, Extract, Clear and Add, Conditional Transfer on Sign of Accumulator, Store, and Modified Store (Multiple).

Registers include 4 recirculating registers. These are the Instruction, Accumulator, Multiplier, and Multiplicand.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	625	156
Mult	4219	3907
Div	4375	4063

Construction (Arithmetic unit only)

Transistors	382
Diodes	3553
Capacitors	347
Transformers	87
Resistors	1894
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	2,560	64,000	10,000 Max 156 Min

INPUT

Media	Speed
Incremental Pulse Train	0-6000 pps
Shaft Position to Binary Coded Discs	Sample: 100/sec Slew Rate: 800 bits/sec

Speed can be made higher

Input/output equipment must be designed for each particular application; however, the particular design and wide applicability of the ASN-24 Computer insures minimum required design effort for input/output equipment.

OUTPUT

Media	Speed
Discretes (voltage pulses)	Max 100 pps

Signals of various time lengths and amplitudes are possible. Signals used to excite other equipment, close relays, etc.

Encoder Disc	Sample: 100 or 200/sec Slew Rate: 800 bits/sec

Can be coupled to synchro, potentiometer, or other similar type shaft mechanism.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	3,553
Transistors	382

Only silicon diodes and transistors are used for high temperature operation capability. These units have high back resistance and low leakage characteristics at high temperatures. The higher collector voltage ratings of silicon transistors permit larger logic swings, these reducing the susceptibility of the computer to noise.

The resistors are 1/4 watt, carbon composition type, have low dielectric loss, DC resistivity, and high thermal shock resistance.

Most of the capacitors are a solid tantalum type which have high dielectric strength and

have no derating of voltage over a large temperature range. The very small capacitors are the subminiature ceramic type.

CHECKING FEATURES

Routines programmed to check all instructions or order codes and the contents of the memory. Discrete signals, suitable for driving indicators, generated to indicate successful completion of check routines. The support equipment includes a Fill-Test Unit, which will fill and check memory contents in conjunction with a tape reader and control the computer program with one-step or loop operation. It also provides test route and synchronization signals for oscilloscope presentation of computer information and Card Checker will check operation of individual circuit and logic cards.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.132 Kw	0.189 KVA	0.7 pf
Does not include I/O			
Volume, computer		0.55 cu ft	
Area, computer		1.42 sq ft	
Weight, computer		37 lbs	

System requires a suitable surface, table, etc., that is fairly steady, can support 31 lbs. etc. System requires only electrical power outlets, 28v DC and 3 phase, 400 cycle AC.

PRODUCTION RECORD

Number produced to date	4
Number in current operation	3
Number in current production	12
Number on order	16

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Supervisors	4
Analysts	1
Programmers	3
Clerks	4
Engineers	20
Technicians	7
Draftsmen	13

ADDITIONAL FEATURES AND REMARKS

Outstanding features include extremely wide variety of applications, operation under sea-level to space environments, light weight, low power drain, in actual operation in field, programmable high speed (200 times (sec). Integration of inputs and/or extrapolation of outputs independent of main authentic section, and data read-out for telemeters.

Basic computer unit designed and in field operation, input-output can be designed to meet a multitude of applications with minimum cost and time expenditures. Tie-in with pulse integrating accelerometers.

Magnetic Memory Drum

Capacity and Tracks:
41 tracks (1600 bits/track) of non-volatile main memory, arranged as follows: 38 tracks with 1 read head each; 2 tracks with 1 read and 1 write head each; 1 track with 1 read head and a 200 bit recirculating register.
1 1600 bit clock track
2 25 bit recirculating registers (2 registers on each of 2 tracks)
1 25 bit recirculating register with 4 additional heads on the same track
1 track with head spacings for either 200 bit or 800 bit recirculation.

Speed:
6,000 rpm

Clock Frequency:
160 kc

Motor:
Location: Contained within drum
Power: 35 watts from 3 phase, 400 cycle, 208 volt Line-Line (60 watts starting power)

Runout:
0.0001 T.I.R.

Drum Assembly Dimensions (including shroud, a head mounting surface surrounding the drum proper; cover; and heads):
6 1/2 inch diameter x 5 11/16 inches long

Drum Assembly Weight (including shroud, cover and heads):
11 1/2 lbs

Drum Surface:
The entire drum surface is milled, similar to the clock track on many other drums (i.e. slotted), with the slots parallel to the axis of rotation. There are 1600 slots around the drum periphery. After milling, the slots are filled with 3M iron oxide.

Heads:
Separate read and write heads are used with this drum. Minimum readback from read head is 0.4 volts peak to peak. The write head requires a 300 ma peak current of 2 microseconds duration through a half-winding. Storage tracks with only read heads requires special techniques.

Environmental Specifications

Ambient Temperature Range:
-55° C to $+100^{\circ}$ C

Humidity:
Entire assembly can be hermetically sealed

Altitude:
Sea-level to space

Shock:
20g for 11 milliseconds

Vibration:
6g from 15 cps to 2000 cps

Constant Acceleration:
10g radially, 3g axially

FUTURE PLANS

Many possible new applications being investigated and radiation testing of circuitry is being planned.

LIBRASCOPE CP 209

Librascope Model CP 209

MANUFACTURER

Librascope Division
General Precision, Inc.

APPLICATIONS

System is used for airborne navigation and bombing ballistics, including loft, and real-time, high speed tracking problems.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	14
Binary digits/instruction	6
Instructions/word	Variable-One, Two or Three
Instructions decoded	30
Arithmetic system	Fixed point

Incremental or Digital Differential Analyzer

Instruction type

System can process 8 operands, storing them in 3 parallel positions.

Number range $\pm (2^{27} - 1)$

Automatic built-in subroutines include integration and sine-cosine.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	59	59
Mult	59	59
Div	177	177 (by sub routine)

Construction (Arithmetic unit only)

Vacuum-Tubes	304
Transistors	100
Condenser-Diodes	4,500
A-D inputs	12
D-A outputs	14

Arithmetic mode	Parallel Arithmetic Units operating Serially
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words
Magnetic Drum	85 Computational Blocks with 4 Integrand Lines

INPUT

Media	
Paper Tape	Used to fill Memory
Analog Digital Converters	200 divisions/sec
Manual Inputs	

OUTPUT

Medium	Speed
Digital-Analog Converters	200 increments/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
6021	33
6111	197
5784-WA	36
5639	36
Diodes	
406621	
Transistors	
2N338	
2N657	

CHECKING FEATURES

Checking features include a diagnostic routine programmed for maintenance.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1.76 Kw
Volume, computer	3.0 cu ft
Area, computer	1.77 sq ft
Floor loading	133 lbs concen max
Weight, computer	133 lbs

PRODUCTION RECORD

Number produced to date	48
Number in current operation	21
Number in current production	6
Number on order	5
Anticipated production rates	5/month
Time required for delivery	10 months

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Operators	1
Technicians	1

Training made available by manufacturer to users includes a factory training course for maintenance men.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Fleet service records indicate that failure-free operation time averages 90%.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a stored program, retraceable sine-cosine operation, K-Line scaling for flexibility and exact multiplication.

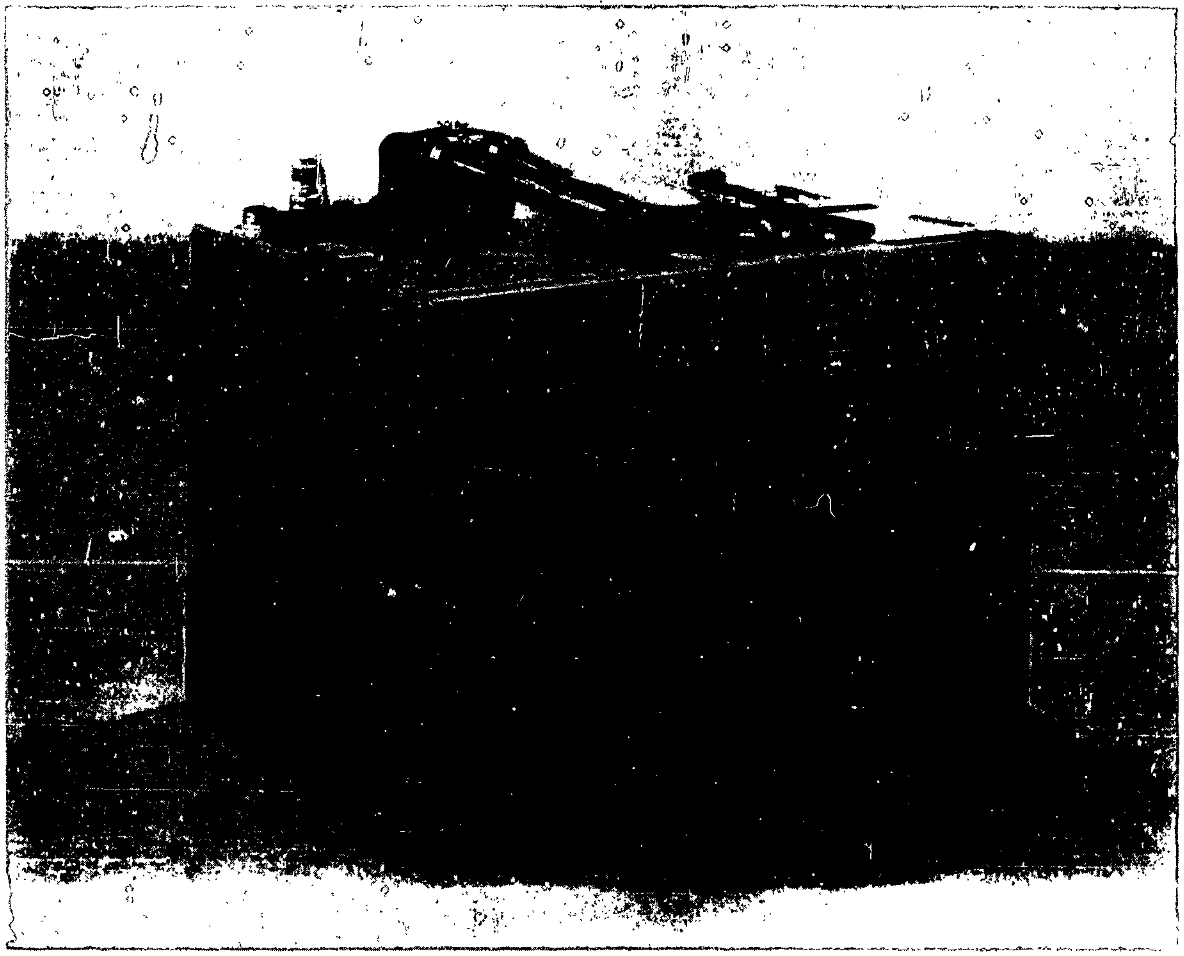


Photo by Librascope Division, General Precision, Inc.

LIBRASCOPE MK 38

Librascope Attack Console Mk 38 (U. S. Navy)

MANUFACTURER

Librascope Division
General Precision, Inc.

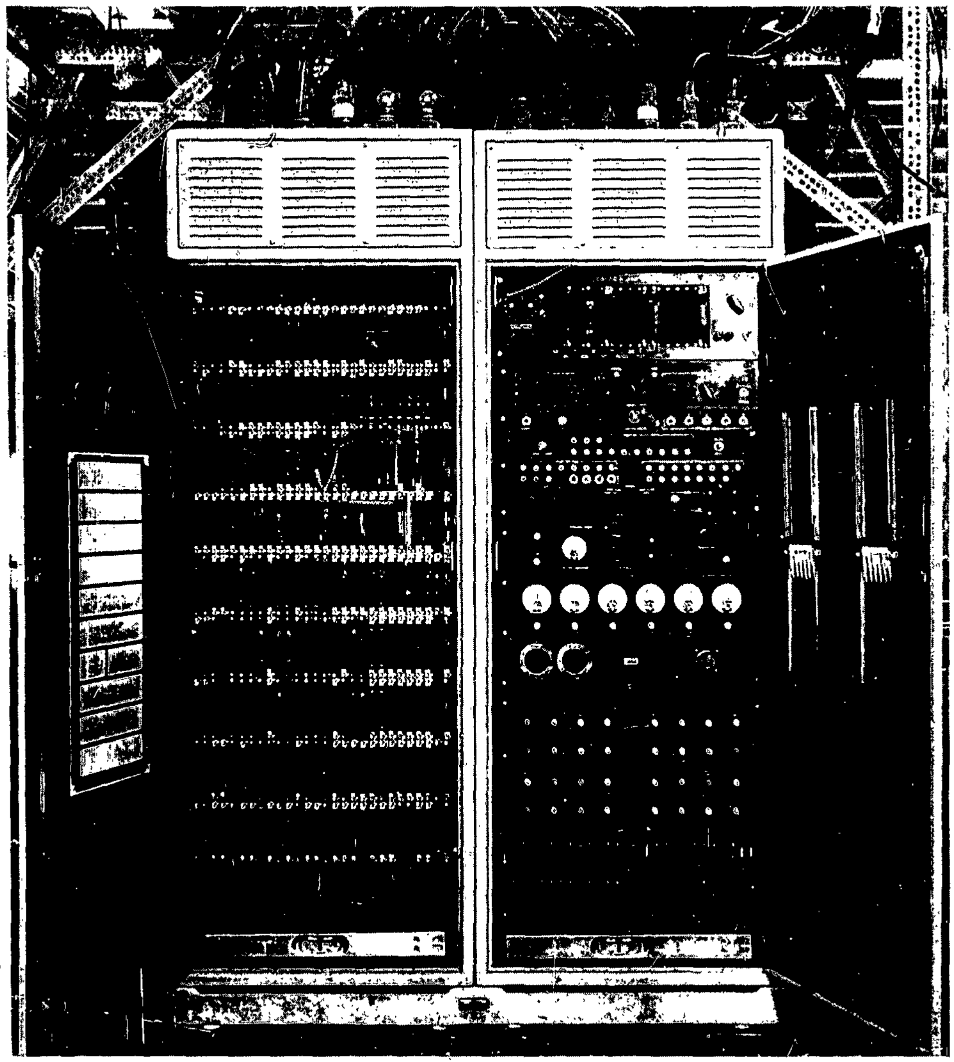


Photo by Librascope Division

APPLICATIONS

The system consists of a serial, incremental, computer consisting of two identical sections working from a common control and input-output section. It is used for real-time fire control problems.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number of binary digits/word	18
Number of binary digits/instruction	5
Number of instructions per word	18
Number of instructions decoded	70
Arithmetic system	Fixed point
Instruction type	One-address operation orders Two-address increment orders Four-address distribution orders

Operation orders consist of integration, remainder, digital servo, transfer, and sine-cosine generation.

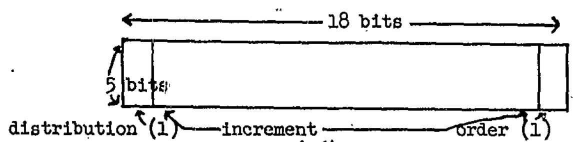
Distribution orders take the increment outputs of the operation orders and store them in temporary registers.

Increment orders communicate the increment outputs

between the operation orders and make decisions on incremental transfers.

Number range $\pm 2^{15}$

Instruction word format



ARITHMETIC UNIT

Operation	Time Microseconds
Integration	72
Remainder	72
Servo	72
Transfer	72
Sine-Cosine	144
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	6,874	122,112	4/bit

INPUT

Media	Speed
Analog-digital converters 32 max, 18 used	Each sampled every 10 millisec.
Switches 16 used	Each sampled every 10 millisec.
Paper Tape	20 char/sec

Tape reader is used for initial fill only.

OUTPUT

Media	Speed
Servo output 32 max, 15 used	Repositioned every 10 millisec.
Relay Lighter 16 used	Repositioned every 10 millisec.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	None
Diodes	
1N621	11,087
1N663	4,275
1N914	128
10Z10.7A	4
1Z12	72
SV128	1
1Z4.7	4
1N647	40
SU122	40
Transistors	
2N697	1,686
2N699	29
2N1252	144
2N1253	704
S4048	

CHECKING FEATURES

Built in Test Program.
Marginal Check Power Supplies.
Card Tester.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer

Volts	cps		Kw	KVA	PF
115	400	3	2.74	3.92	0.70
115	400	1	1.109	2.64	0.42
115	60	1	0.032	0.115	0.28
28	60	1	0.29	0.29	1.00
28	DC		0.294	0.294	1.00

Volume, computer	26.67 cu ft
Area, computer	4.67 sq ft
Room size, computer	8 x 9 ft
Power, air conditioner	Forced air
Weight, computer	3,000 lbs, Total (Includes Analog Section)

Refer to OP 2687 for installation requirements.

PRODUCTION RECORD

Number produced to date	14
Number in current operation	3
Number in current production	6
Number on order	54
Anticipated production rates	3 per month

Above data is as of 29 June 60

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Supervisors	1
Operators	2
Technicians	1

Training made available by manufacturer to users includes a 6 month course for Navy personnel at Key West for operation and maintenance of entire system.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability include built in test programs, giving both identical sections the same program for comparison testing, a card tester with fixed pattern for testing all circuit cards, silicon components used for greater heat stability, and pluggable etched circuits cards for quick replacement.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include the option to reprogram the fixed program gives the computer the facility of handling a weapons system compatible with the number and range of analog-digital converters.

FUTURE PLANS

Plans include continued adaptation of computing equipment to any rocket thrown torpedo or similar missile requirement. Incorporation of electric set and wire-guide torpedoes as well as other short range weapons.

LIBRASCOPE MK 130

Librascope Digital Computer Mk 130 Mod 0 (U.S. Navy)

MANUFACTURER

Librascope Division
General Precision, Inc.

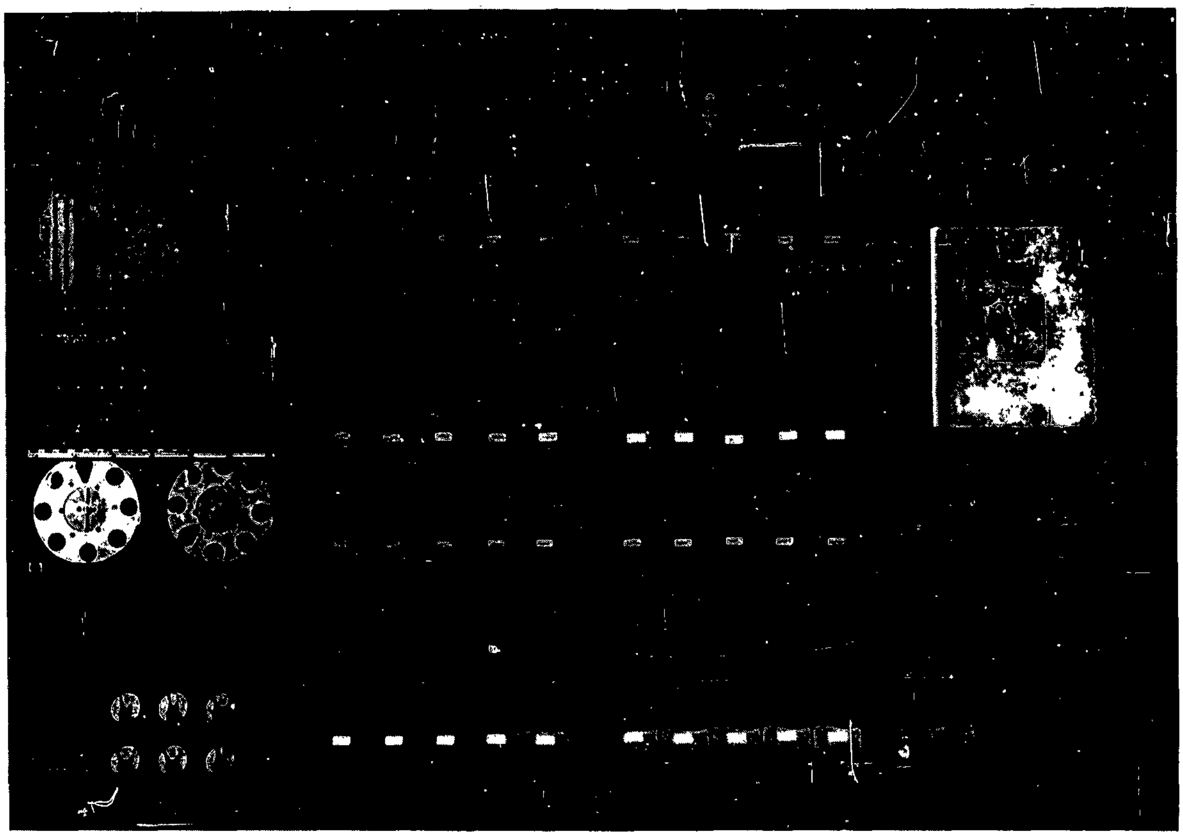


Photo by Librascope Division

APPLICATIONS

Computer performs target motion analysis, target prediction, and data smoothing for Fire Control System Mk 113.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number of binary digits/word	18 bits plus sign
Number of digits per instruction	5 bits for address orders 7 bits for non-address orders
Arithmetic system	Fixed point

Floating point is programmed as a subroutine of two consecutive words; 8 bits are used for the exponent and 30 bits are used for sign and numeric value.

Instruction type	One address
Number range	0 to $(2^{19} - 1)$

Instruction word format

Addressable order

1	5	1	12
Sign	Order	B	Address

Non-address order

1	13	5
Sign	Non-Address Order	I/O Device Designation or Number of places for shifts

Automatic built-in subroutines

The trapping of control is dependent on the overflow of the delay line (relative clock). When trapped, computer obeys the instruction in location $(0002)_{10}$ of memory.

Registers and B-boxes

One B Modification register, usually known as

index register.

Approximately 3,650 instructions are decoded for a fire control program.

There is also an indirect addressing feature available. A bit in the sign position is utilized for this purpose. This differs in that instead of referring to an address 0001 the desired address is found in location 0001. This process may be carried further.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec.	Exclud. Stor. Access Microsec.
Add	40	16
Mult	40-424	16-400
Div	40-460	16-436

Construction (Arithmetic unit only)	Transistors
Arithmetic mode	Parallel
Timing	Synchronous
Operational	Sequential

The machine has a microprogram unit which controls its function. The microprogram unit is synchronous, the arithmetic unit is asynchronous.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec.
Magnetic Core Memory	4,096	Sign digit + 18 digits	20

No magnetic tape is associated with the Mk 130 Mod 0.

INPUT

Media	Speed
Switch Bank on test panel	Instantaneous

Information is read directly into the accumulator.

Analog Modules (Digital Data from Shaft encoders)	157 times per second

Information is converted from analog voltages to binary via I/O Buffer, is read into the K Register. From the K Register, the program gets the information into the Accumulator.

Flexowriter or Ferranti tape reader	Photo reader original rate 530 chars/sec

The speed is dependent on the amount of tape on the reel.

Switches in Mk 50, Mk 51, and Mk 75 of FCS Mk 113 and all Mods, and Sensor operator's Mark Signals	128 micro sec pulses

Some of these signals are stretched to more than 2.25 seconds.

OUTPUT

Media	Speed
Analog Modules (Digital data from shaft encoder)	157 times/sec

Program transfers information from Accumulator to K Register, then via I/O Buffer to analog components.

Light Banks on test panel	Instantaneous

The accumulator and the counter register are displayed.

Lights on Mk 51 of FCS Mk 113 all mods	Instantaneous

For quality of sol'n lights, relative course light, constraint lights, etc.

To relays in Mk 50, 51 and 75 of FCS Mk 113 all mods	Instantaneous

To signal that range, course, speed, and bearing for a particular channel has been calculated and are available as analog information.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	None
Diodes	
1N251	97
1N270	76
1N429	38
1N537	11
1N645	97
1N659	11,762
1N663	2,412
1N749	22

Does not include diodes in which less than 10 per type are used.

Transistors	
2N335	20
2N388	1,317
2N501	3,232
2N597	68
2N599	2,361
2N665	17

Does not include transistors in which less than 10 per type are used.

Magnetic Cores 82,000

Used in computer memory and switching.

The Mk 130 Mod 0 uses "resistor coupled transistor logic" (RCTL) or "nor" logic throughout.

CHECKING FEATURES

Fixed checking features include a card test panel, capable of checking all circuit boards, a computer test panel, providing manual communication with all portions of computer, and a margin check panel, wherein switch settings determine voltage variation for marginal checking.

Optional checking features include a test console, which can duplicate computer test panel and in addition can furnish input/output facilities of flexowriter, high speed punch, switch inputs, camp outputs, digital shaft encoders, and output servo modules. It is used for factory checkout only.

Existing computer circuitry can be utilized to activate portable flexowriter or high speed punch without use of test console if desired. Portable input/output devices not available at this time but can be developed with minimum design effort.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

	Kw	KVA	Power Factor	Remarks
Power, computer	2.85	3.15	0.9	400 cps, 3ø, 115V
	1.97	1.54	0.8	60 cps, 1ø, 115V
	.21	.21	1.0	26V, DC

Volume, computer	27.4 cu ft
Area, computer	6.7 sq ft
Floor loading, computer	244 lbs/sq ft
	244 lbs concentrated max.
Weight, computer	Approx. 1,647 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	1
Number on order	8
Anticipated production rates	1 per month
Time required for delivery	6-8 months

PERSONNEL REQUIREMENTS

Training made available by manufacturer to users includes a factory maintenance course on the Mk 130 digital computer, which comprises 3 to 4 weeks of instruction. The Mk 130 digital computer is an unmaned piece of equipment in its tactical application. Maintenance will be performed by user personnel (U.S. Navy) aided by Librascope Field Service.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

All circuitry is completely transistorized and mounted in readily accessible modules. Test points have been provided on all circuit modules and chassis assemblies for ease of maintenance. A circuit module tester capable of testing all circuit modules is provided as part of the digital computer. All subassemblies are accessible from the front of the computer. Diagnostic routines are available to the user. Circuitry is conservatively designed and will operate over an ambient temperature range of 0°F to 110°F. During prototype evaluation only two failures have occurred in over 1000 hours of operation.

ADDITIONAL FEATURES AND REMARKS

Unique system advantages include a micro-program unit which can be modified to create new or variations of existing commands to tailor computer operation to suit individual situations without major redesign.

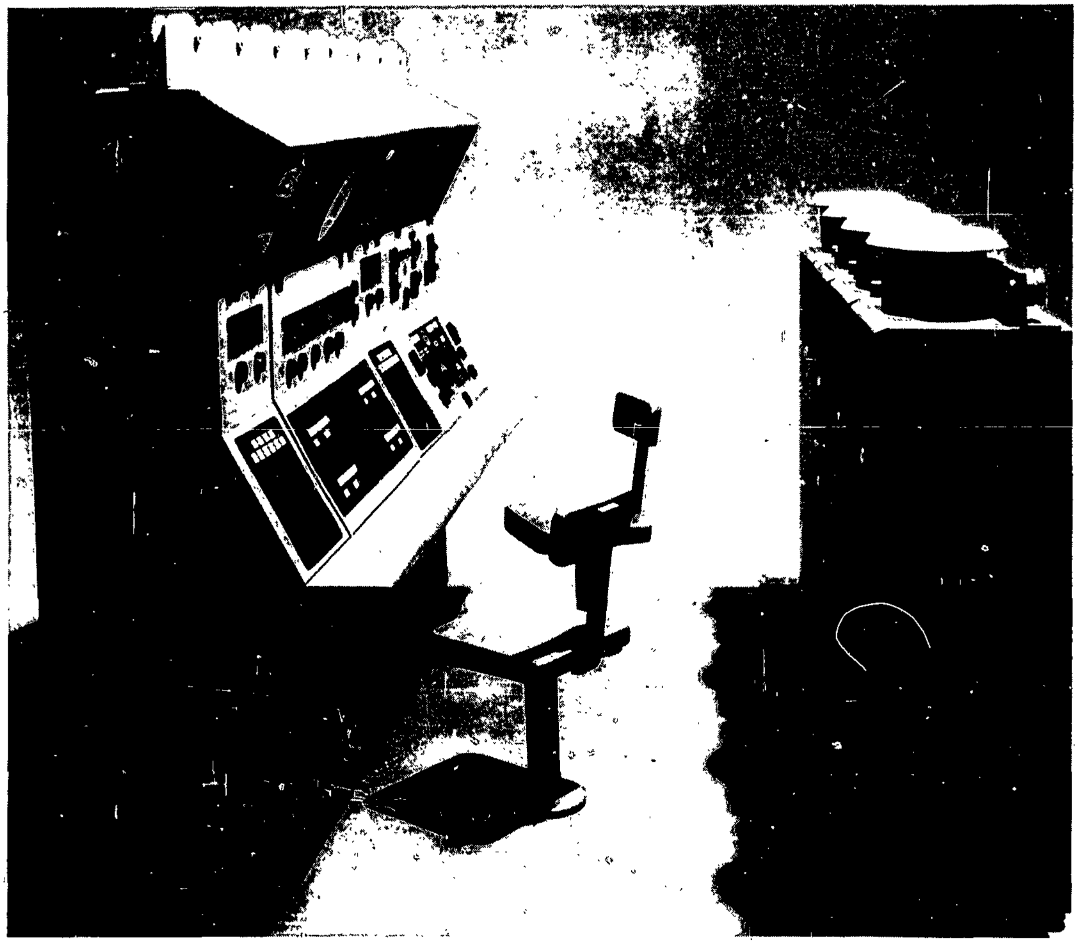
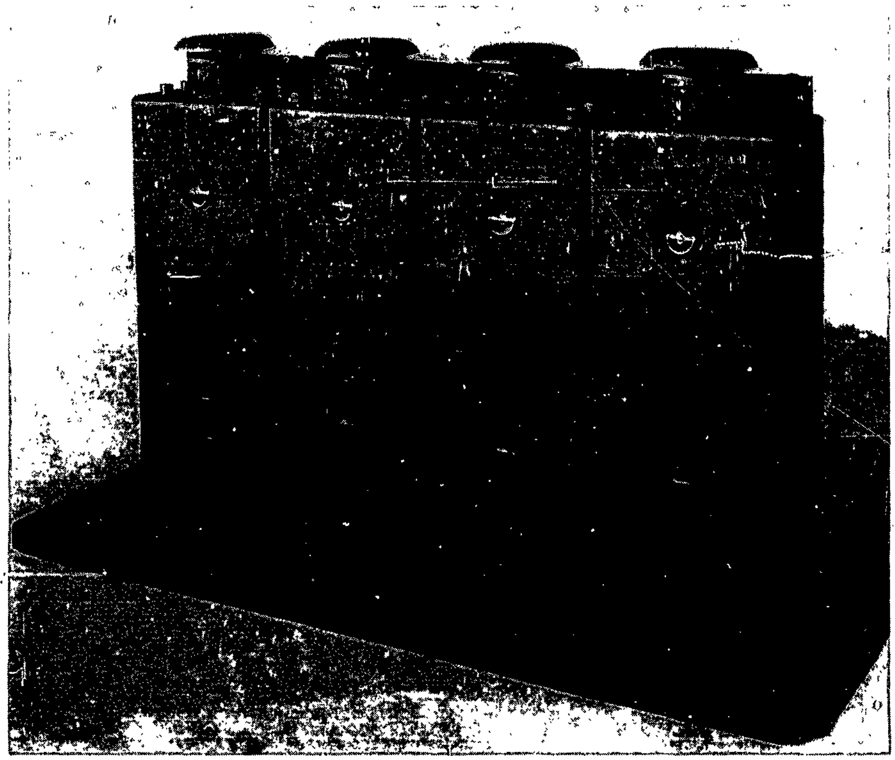
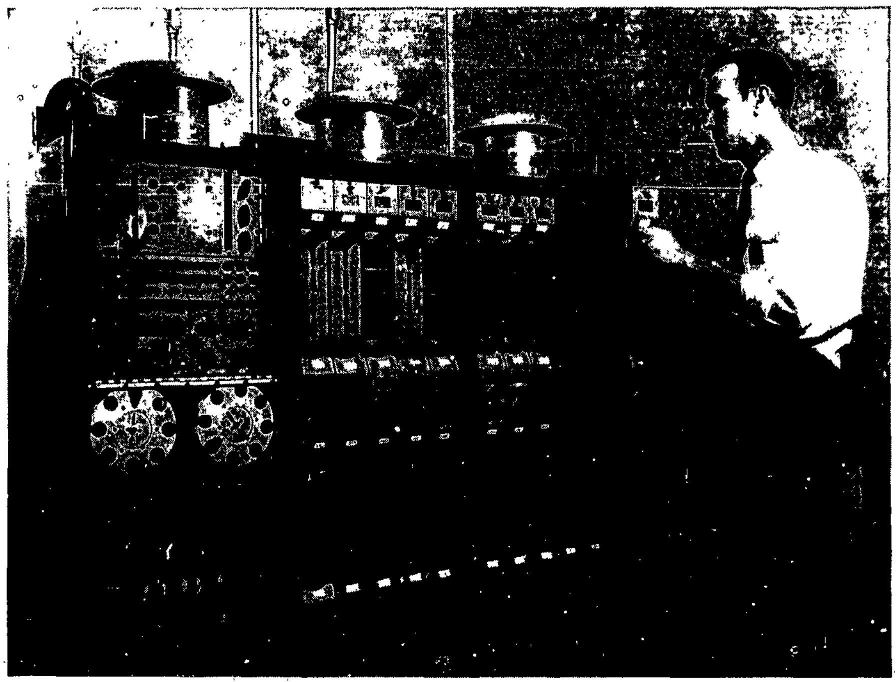


Photo by Librascope Division, General Precision, Inc.





Photos by Librascope Division, General Precision, Inc.

LIBRATROL 500

Libratrol 500 Computing System

MANUFACTURER

Librascope Division
General Precision Equipment Corporation

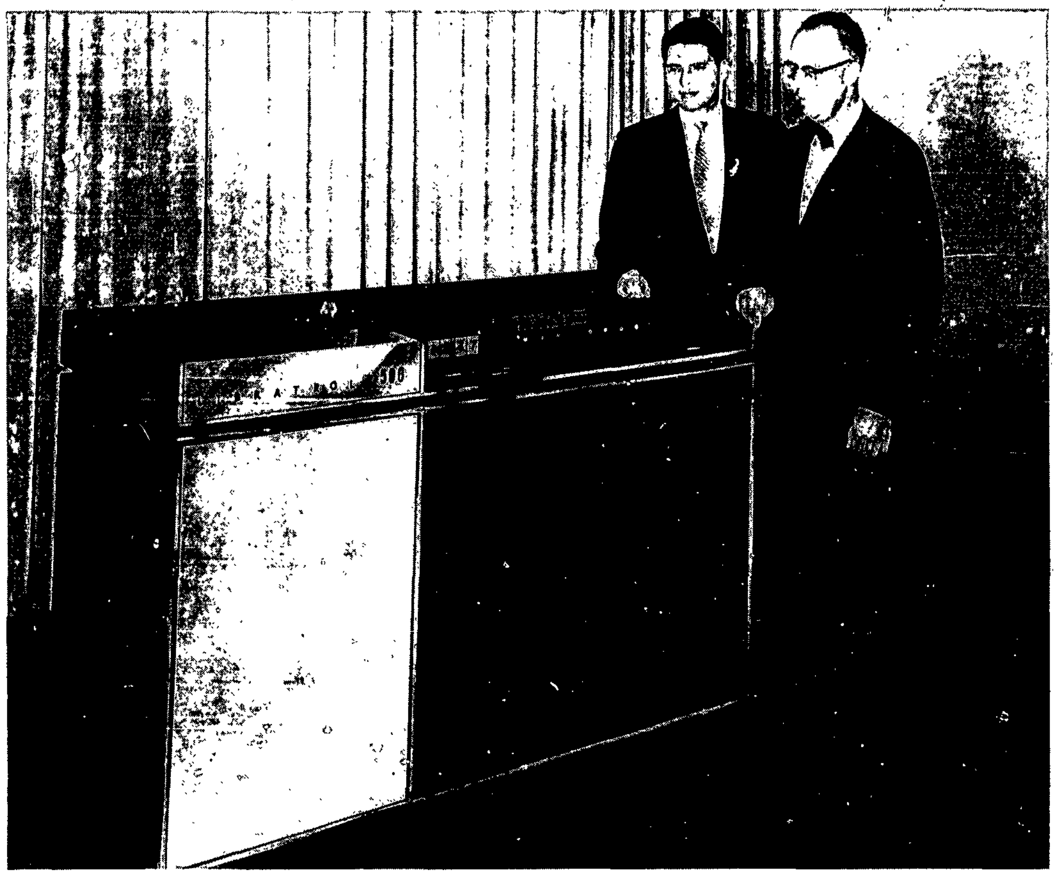


Photo by Public Service Company of Colorado

APPLICATIONS

Manufacturer

General purpose computing where computing equipment must communicate directly with equipment external to the computer, via digital inputs or via voltage inputs.

General purpose computing where computing equipment must send control signals to equipment external to the computer.

Examples of applications are quality control for both continuous and batch production processes-real time, process control for both continuous and batch processes, and equipment test stand instrumentation (data acquisition, logging and calculation).

Frankford Arsenal

This computer is being incorporated into a breadboard of an automatic checkout system, the purpose of which is to automatically and rapidly test and evaluate the performance of combat vehicles. The above tasks include fault isolation of malfunctioning components or parts, the preparation of logictics data in the English language, and record keeping of items which pass through the test station. The first item to be so tested will be of the engine and transmission system of the M48A1 combat tank.

Public Service Co. of Colorado

Located on West 3rd Avenue and Lipan Street, Denver, Colorado, the system is used on-line for calculation of hourly gas loads delivered into company systems by suppliers. Input by telemeter from remote stations through digital converter to computer. It is also used off-line for calculation and printing of orifice meter deliveries to gas customers, input by paper tape, and miscellaneous engineering problems, as they arise.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	30 bits plus sign
Binary digits/instruction	4
Instructions per word	1

Photo by Frankford Arsenal

Integrated System

Instructions decoded	16
Arithmetic system	Fixed point

Floating point is programmable.

Instruction type	One address

0	1 12	13 16	17 18	19 24	25 30	31	Sp
Sign		Instruction		Track	Sector		Spacer

A complete set of compiler and utility programs are available.

Registers include counter register, accumulator, and instruction register.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	7,750 (Mean access)	250
	23,000 (Mean access)	15,000
	23,000 (Mean access)	15,000

Construction (Arithmetic unit only)

Vacuum tubes	175
Diodes	1,750
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Though operation is listed as being sequential, the input system of the LIBRATROL 500, since it is independent of the computing portion of the machine, is capable of inputting information while calculation is proceeding concurrently.

STORAGE

Manufacturer

Media	No. of Words	No. of Digits
Magnetic Drum (Main)	4,096	126,976
Magnetic Drum (Buffer)	64	1,984

Access time is variable between 500 and 15,000 microseconds.

Magnetic tape will be developed.

Frankford Arsenal

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	4,096	31 binary	9,000 (avg)

Public Service

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	4,096	32 binary	

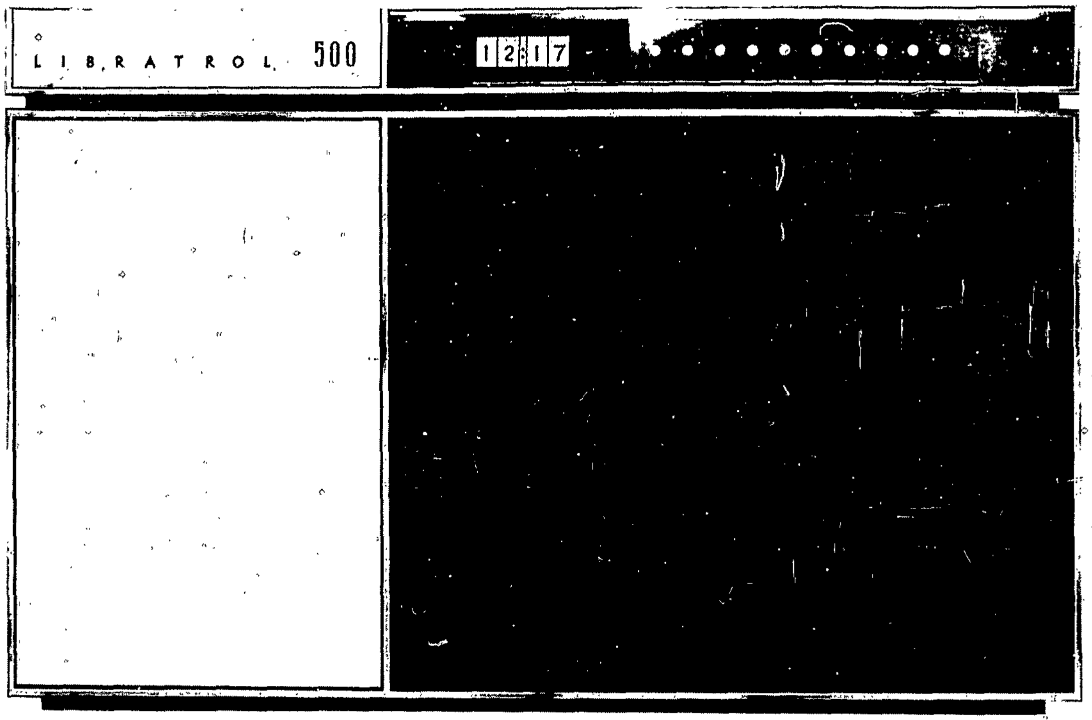


Photo by Librascope Division, General Precision

INPUT

Manufacturer

Media	Speed
Analog	60 samples/sec
Digital	60 char/sec
Paper Tape	10 or 60 char/sec
Typewriter	10 char/sec

Above items are standard.

Frankford Arsenal

Paper Tape	approx 5 char/sec

Mechanical tape reader.

Flexowriter used and input also available through Flexowriter keyboard.

Public Service

Electric Typewriter	570 char/min
Analog-Digital Converter	75 words/sec

Data can be supplied by punched paper tape.

OUTPUT

Manufacturer

Medium	Speed
Paper Tape	10 char/sec

Frankford Arsenal

Flexowriter	approx 8 char/sec

Public Service

Electric Typewriter

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type				Quantity
Tubes				
6AN8	5915	5965	2D21	
5687	5963	6197	3RP1A	Total 175 approx
Diodes				
1N617				1,450 approx

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	2.5 Kw
Volume, computer	49 cu ft
Area, computer	13.7 sq ft
Room size	24 sq ft
Floor loading	78 lbs/sq ft
Weight, computer	1,000 lbs (nominal)

A separate 115 volt, 20 ampere circuit is recommended.

Frankford Arsenal

Power, computer	2.3 KVA
Volume, computer	30 cu ft
Area, computer	10 sq ft
Room size	20 ft x 60 ft
Weight, computer	1,000 lbs

Public Service

Power, computer	2 Kw
Power, air condi (2 required)	7.25 Kw each
Volume, computer	47.4 cu ft
Volume, air conditioner	89.4 cu ft each
Area, computer	13.22 sq ft
Area, air conditioner	29.8 sq ft each
Floor loading	110 lbs/sq ft
Capacity, air conditioner	7.5 Tons, each
Weight, computer	1,450 lbs

Reinforced floor (wood).

PRODUCTION RECORD

Manufacturer

Number produced to date	Over 400
Number in current operation	380
Number in current production	15
Number on order	15
Time required for delivery	3 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Cost
1 Libratrol 500 Computer with 120 input channels and analog to digital converter	$84,500
Frankford Arsenal	
Basic System	
Computer and Flexowriter	89,000
Additional Equipment	
Commutator extender	5,000
Digital inputs & high speed input mode	20,000
300 magnetic latching mercury wetted relays	20,000
Spare parts	5,000
D/A converters (5)	1,000
Total	$51,000
Public Service	
Basic System	
Computer, Digitizer, 1-Flexowriter	90,000
Additional Equipment	
1-Flexowriter	4,000

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	1	1
Programmers	1	1	1
Operators	1	2	3
Engineers	1	1	1

Thirty days of instruction time is included in the sale price for programming and maintenance training of customer personnel.

Frankford Arsenal

	One 8-Hour Shift Used	Recommended
Programmers	1.5	1.5

Method of training is informal.

Public Service

The department, which is the principal user of this computer has 16 employees. The two engineers in the department, program and maintain the computer. Two girls prepare tapes and, to a large extent, operate the computer, and file tapes and work sheets. While it is planned to train additional department personnel to work with the computer, there is no need for increasing the number of employees doing any one computer job.

Methods of training includes on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

The combination of conservatively rated, carefully engineered components, with simplicity of design, conspires to allow the computing elements to function with only 113 vacuum tubes. Reliability should normally exceed 99% up-time over a 6 month period.

Public Service

Good time	166 Hours/Week (Average)
Attempted to run time	168 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.988

Above figures based on period 1 May 60 to present

Time is available for rent to qualified outside organizations.

The reliability figures refer only to basic computer operation. We have had difficulty with input of data through the analog-digital system which has been combined with the computer. Reliability figures on the total system would be greatly lower. Because of the input problem the system has not as yet been accepted.

ADDITIONAL FEATURES AND REMARKS

Public Service

An outstanding feature is that the system permits computer-controlled input of telemetered values. It has two Flexowriters (off-line and on-line) which are controlled by the program.

The fact that the system permits working off-line programs and a continuing on-line program is a unique advantage.

FUTURE PLANS

Frankford Arsenal

It should be noted that the Libratrol 500 Computer has been assimilated into the Automatic Checkout equipment. It is now merely a component of the system, and is no longer identifiable as a Libratrol 500 Computer. The questionnaire answers, however, are with respect to the computer portion of the checkout system only, i. e., only the computer memory is discussed although additional memory capability is inherent in the checkout system.

Public Service

Possible replacement in 5 or 6 years is planned.

INSTALLATIONS

U. S. Army Ordnance Arsenal, Frankford
Bridge and Tacony Streets
Philadelphia 37, Pennsylvania

Public Service Company of Colorado
900 15th Street
Denver, Colorado

LIBRATROL 1000

Libratrol Computing System Model 1000

MANUFACTURER

Librascope Division
General Precision Equipment Corporation

Photo by Librascope Division, General Precision, Inc.

APPLICATIONS

System is intended for general purpose computing, where computing equipment must communicate directly with equipment external to the computer via digital or voltage (analog) inputs and where computing equipment must develop control signals to equipment external to the computer. Examples of applications are quality control for both contonuous and batch production processes-real time, process control for both continuous and batch processes, and equipment test stand instrumentation - data acquisition, logging, and calculations.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	32
Binary digits/instruction	5
Instructions per word	1
Instructions decoded	32
Arithmetic system	Fixed point

Floating point is programmable.

Instruction type	Two address

Instruction word format

	Operand Address		Next Inst Address		
S1 4	5 11	12 17	18 24	25 30	31
Command	Track	Sector	Track	Sector	Address Modify Flag

A complete set of compiler and utility programs are available.
Additive index register and double length accumulator.
Lower accumulator can be made to operate on eight words at a time.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	1,000	250
Mult	17,000	16,250
Div	17,000	16,250

Arithmetic mode Serial
Timing Synchronous
Operation Sequential

Though operation is listed as being sequential, the input system of the L-1000, since it is independent of the computing portion of the machine, is capable of receiving information while calculation is proceeding concurrently.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum (Main)	8,000	256,000	250
Magnetic Drum (Buffer)	64	2,016	250
Magnetic Tape			

No. of units that can be connected 64 Units
Magnetic tape is a future development.

INPUT

Media	Speed
Analog	60 samples/sec (2,000 samples/sec optional)
Digital	60 char/sec (Standard)
Paper Tape	10/60 char/sec (Standard)
Typewriter	10 char/sec (Standard)

OUTPUT

Media	Speed
Paper Tape	60 char/sec (Optional)
Typewriter	10 char/sec (Standard)
Control (analog or digital)	120 char/sec (Standard)
Line Printer	300 char/sec (Optional)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	
Tubes		
CRT	1	(digital display for monitoring)
Diodes		
1N617	2,400	
Transistors	650	(basic system)
2N1301		
2N393		
2N404		
2N357		
2N597		
2N1130		

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	2 Kw
Volume, computer	48 cu ft
Area, computer	12 sq ft
Room size	24 sq ft
Capacity, air conditioner	1 Ton
Weight, computer	1,000-1,200 lbs

Air conditioner is included and self-contained

PERSONNEL REQUIREMENTS

One operator required for each shift.
Training made available by the manufacturer to the user includes programming and maintenance.

FUTURE PLANS

Magnetic tape input and a core buffer unit are planned.

INSTALLATIONS

Librascope Division
General Precision Equipment Corporation
808 Western Avenue
Glendale, California

LINCOLN CG 24

Lincoln CG 24

MANUFACTURER

Massachusetts Institute of Technology
Lincoln Laboratory

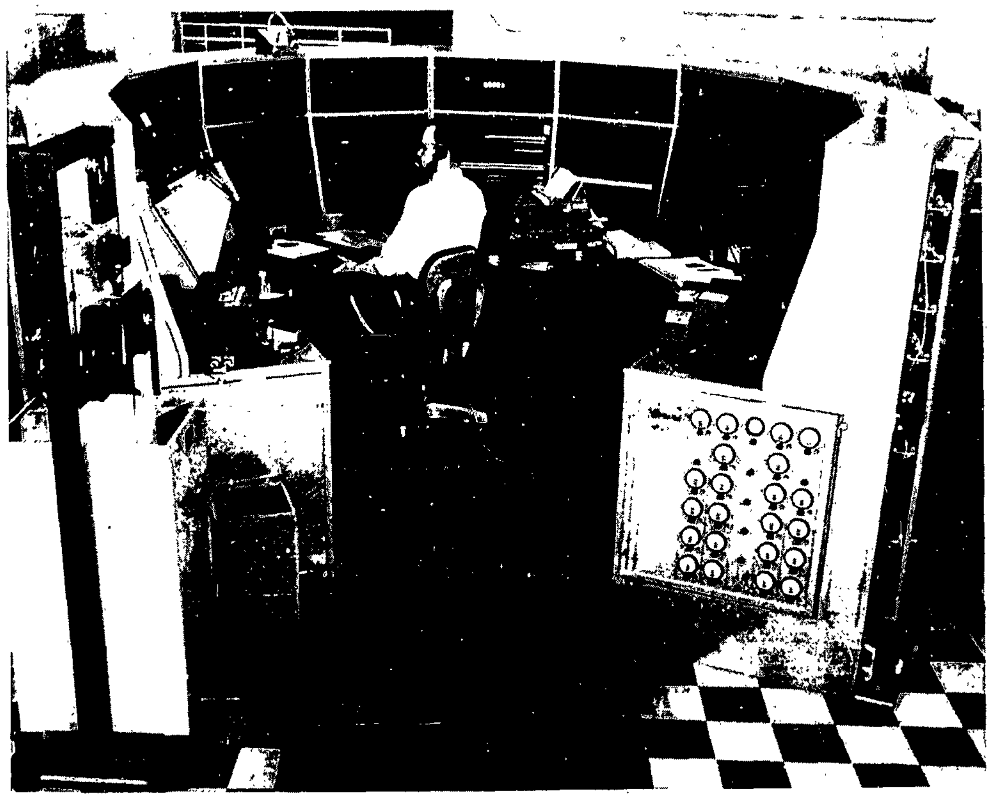


Photo by Massachusetts Institute of Technology

APPLICATIONS

CG 24 is a general purpose computer attached to a long-range radar both for receiving detected echoes and for directing the antenna. It is operated in real time primarily for the collection and processing of radar tracking data. Storage of such data is made directly into high-speed memory under program control. The research was supported jointly by the Department of the Army, the Department of the Navy, and the Department of the Air Force under Air Force Contract No. AF 19(122)-458.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number of binary digits/word	24 plus sign
Number of binary digits/instruction	24
Number of instructions/word	1
Total number of instructions decoded	46
Arithmetic system	Fixed point
Instruction type	(Floating point sub-routines) One address
Number range	$-1 \leq n \leq 1 - 2^{-24}$

Instruction word format

Bit	0-3	4-9	10-24
	Index	Instruction	Address

Registers and B-boxes include 5 sets of registers of 8 bits each and a real time clock register.

Negative numbers are treated in two's complement form.

Arithmetic algorithms handle either positive or negative numbers.

CG-24 CHARACTERISTICS

GENERAL

CONSTRUCTION : SOLID STATE
APPLICATION ·····GENERAL-PURPOSE PLUS REAL-TIME CONTROL
TIMING ········SYNCHRONOUS, 330 Kcps.
OPERATION ······SEQUENTIAL, SUBJECT TO SELF-MODIFICATION

NUMERICAL SYSTEM

INTERNAL NUMBER SYSTEM ···· 27-BIT BINARY WORDS, INCLUDING TWO PARITY BITS

SINGLE-ADDRESS INSTRUCTIONS.

FIXED-POINT ARITHMETIC SYSTEM, PROGRAMMED FLOATING POINT SUBROUTINE.

ARITHMETIC UNIT

ADDITION TIME ·············· 24 μs (incl. memory access)
MULT.-DIV. TIME ·············· 84 μs (" " ")
SQUARE ROOT TIME··········· 300 μs (" " ")

STORAGE SYSTEM

8192 WORDS, COINCIDENT CURRENT MAGNETIC CORES, 12 μs CYCLE TIME

TERMINAL EQUIPMENT

FLEXOWRITER
CRT DISPLAY WITH NUMERIC GENERATOR
PHOTOELECTRIC TAPE READER.

C314-16

Photo by Massachusetts Institute of Technology

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	24	12
Mult	84	74
Div	84	74

Construction, arithmetic unit only
Arithmetic unit consists of transistors and diodes.
Arithmetic mode Parallel
Multiplication and division operations consist of serially adding or subtracting. Addition and subtraction are parallel operations.
Timing Synchronous
Operation Sequential and concurrent

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	8,192	27/word	12
Magnetic Tape	5×10^5 binary words/tape	24/word	272

No. of units that can be connected	7 Units
No. of characters/linear inch	200 Chars/inch
Channels or tracks on tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Chars/sec
Start time	5 Millisec
Stop time	1.5 Millisec
Average time for experienced operator to change reel of tape	90 Seconds
Physical properties of tape	
Width	1/2 Inches
Length of reel	1,200 Feet
Composition	0.0015 in mylar

The 7-channel digital tape units are Ampex FR-300 with packing density of 200 bits/inch in each channel. These are operated at 75 in. per second. Two units were installed in August 1960.

INPUT

Media	Speed
Magnetic Tape	15,000 char/sec 6 binary digits/char
Paper Tape	200 char/sec 6 binary digits/char Ferranti Photoreader
Keyboard	Flexowriter
Manual	Toggle switch

OUTPUT

Media	Speed
Magnetic Tape	15,000 char/sec 6 binary digits/char
Paper Tape	135 char/sec 6 binary digits/char Soroban Punch
Keyboard	570 ltrs/min on line Flexowriter
Display with camera	18,000 octal digits/sec Numbers are formed as Lissajou figures from X-Y inputs

Two servo units are connected to the lower accumulator in such a fashion as to provide for program control of elevation and azimuth angle synchro data for a radar antenna.

In June 1960 an alpha-numeric display (using the 6 bit Flexowriter code) was connected to CG 24. It has added photographic facilities. It includes two CRT's. The speed is 75 microseconds per figure or letter.

An input buffer provides for real time input of radar position and range rate data.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
K1354P11M	1
K1354P7M	1
5965	6
6080	2
6073	7
5651	4
6BL7	1
8013	2
12AX7	2
2D21	2
CRT display circuits	
Diodes	
S347G	21,700
SG22	7,900
HD2085	3,600
Total	33,200
Transistors	
4JD2A6	7,950
2N123	6,250
2N385	2,850
M201Z	875
GT34	500
CK750	320
904A	185
GT83	60
Total	18,930
Magnetic Cores	
S-1 Ferrite	229,376

Component count as of May 1958

CHECKING FEATURES

Fixed
- Core memory: parity check on each half word
- Magnetic tapes: parity check (IBM mode)
- Perforated tapes: modulo 25 check sum.

Optional
- Magnetic tapes: Programmer may use error correcting mode. This provides 2 error detection, 1 error correction. The mode gives 3 of the 7 tracks for data.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	4.6 Kw (May 1960)
Power, air conditioner	4.5 Kw (Including Room)
Volume, computer	680 cu ft
Area, computer	110 sq ft
Room size allocated	1,200 sq ft
Capacity, air conditioner	5 Tons
Weight, computer	5,000 lbs

The computer requires 110 sq. feet of floor space. A set of 3 rooms (total area 1200 sq. ft.) is devoted to computer, tapes, maintenance, stock and input buffers. The air conditioner supplies 2500 cu. ft/min. from an 11-inch high plenum underneath the computer proper. The air conditioner services other parts of the building. The 5 ton capacity is an estimated fair proportion. Computer logic power is derived from 400 cycle rotating machinery.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

System is not being produced.

COST, PRICE AND RENTAL RATES

CG 24 was built as part of an experimental prototype system. It cost approximately $1,000,000.

PERSONNEL REQUIREMENTS

Typical Personnel	One 8-Hour Shift
Supervisors	1
Programmers	4
Operators	1
Engineers	1
Technicians	1

RELIABILITY, OPERATING EXPERIENCE AND TIME AVAILABILITY

CG 24 has been operating for about 2 years. It has been on power almost constantly, being operated an average of 8 hours per day.

Faults have been primarily due to connections (Arkless wiring originally unsoldered has been soldered), other contacts and receptacle pins, memory adjustments (generally not component failures), and photo reader (generally not component failures). Qualitatively, it is difficult to assign many (if any) semiconductor failures to aging. Rather, most are traceable to man-made shorts.

ADDITIONAL FEATURES AND REMARKS

Unique system advantages include a very flexible arrangement for receiving and processing long range radar echo data, for directing antenna, and for simulating major parts of receiving and processing equipment.

INSTALLATIONS

Lincoln Laboratory
Massachusetts Institute of Technology
Lexington, Massachusetts

LINCOLN TX O

Lincoln Test-Experimental Computer Model 0

MANUFACTURER

Lincoln Laboratory
Massachusetts Institute of Technology

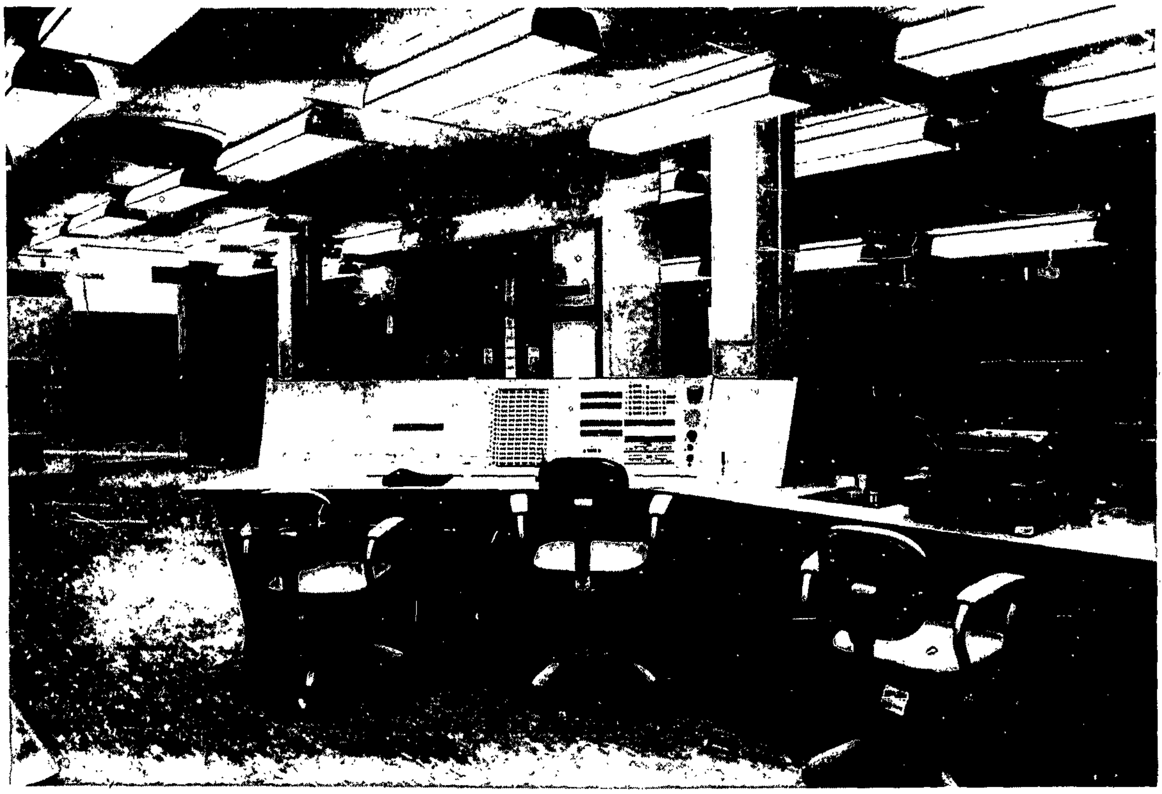


Photo by Lincoln Laboratory, Massachusetts Institute of Technology

APPLICATIONS

Manufacturer

An experimental digital computer used to test advance design techniques, including very large core storage and transistor circuitry.

The research reported in this computing system description was sponsored jointly by the Army, Navy and Air Force under contract with the Massachusetts Institute of Technology.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	18
Binary digits/instruction	18
Instructions/word	1
Instructions decoded	25
Arithmetic system	Ring-adder
Instruction type	One address
Number range	Not appropriate

Three instructions are addressable and 1 is microprogrammable.

ARITHMETIC UNIT

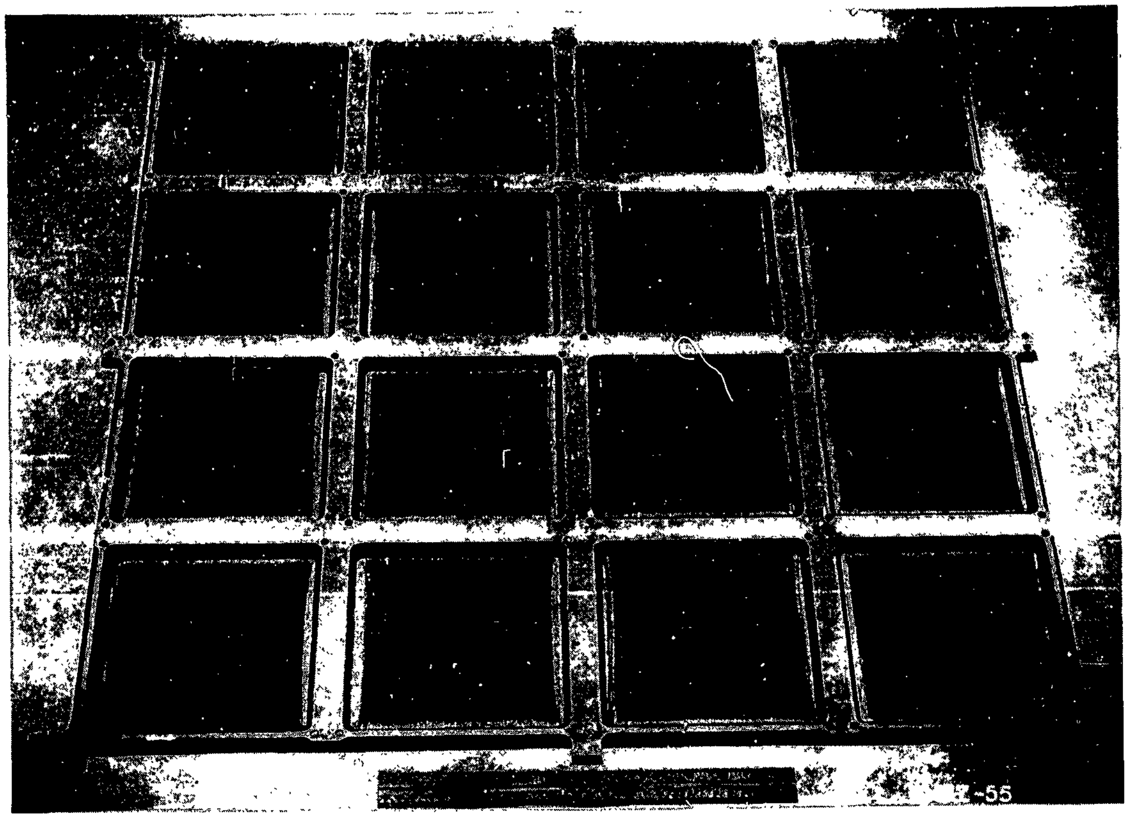
	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add time	6	1
Mult time	1,000	1,000
Div time	1,000	1,000
Construction		1,000 transistors
Arithmetic mode		Parallel
Timing		Synchronous
Operation		Concurrent

Computer performs 83,000 additions per second. Mulitply and divide is programmed.

STORAGE

Media	Words	Digits	Microsec
Magnetic Core	65,536	18/word	3
Flip-flop	1	18/word	0.5
Toggle Switch	16	18/word	3

A parity bit is additional. Read-rewrite time is 6 microseconds.



LINCOLN TX 0 and TX 2 Memory Plane   Photo by Lincoln Laboratory, Massachusetts Institute of Technology

INPUT

Media	Speed
Photo Reader	250 lines/sec
Flexowriter	Manual
Toggle Switch	Manual

OUTPUT

Media	Speed
Flexowriter	10 char/sec
Display (CRT)	16 microsec/spot

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	440
Tube types	3
Crystal diodes	350
Magnetic cores	1,245,773
Transistors	3,500
Separate cabinets	5

Three major tube types, a small number of others. Most tubes are used in the large memory. The transistors are the Philco L-5122 Surface Barrier Transistor.

CHECKING FEATURES

Parity check on memory systems. Marginal checking is built in.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	10 Kw
Volume, computer	1,000 cu ft
Area, computer	200 sq ft
Capacity, air conditioner	40 Tons
Weight, computer	4,000 lbs

Above figures are approximate. Air conditioner is necessary for memory only.

PRODUCTION RECORD

Number produced	1
Number in operation	1

ADDITIONAL FEATURES AND REMARKS

One picture shows close-up view of magnetic core memory plane and other picture shows random-access core memory, frame of memory-core selection-switch drivers, computer arithmetic element and control element, and computer operating console.

INSTALLATIONS

Lincoln Laboratory
Massachusetts Institute of Technology
Lexington 73, Massachusetts

LINCOLN TX 2

Lincoln Test Experimental Computer 2

MANUFACTURER

Lincoln Laboratory
Massachusetts Institute of Technology

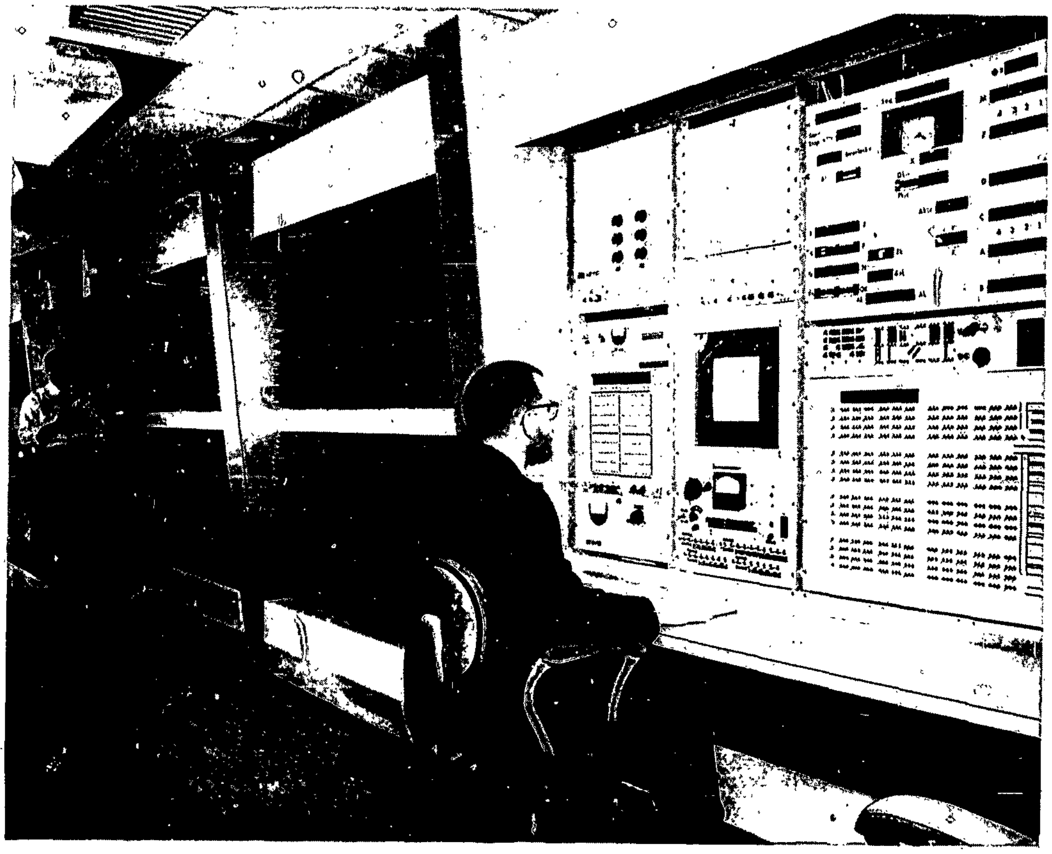


Photo by Lincoln Laboratory, MIT

APPLICATIONS

Computing system is used for scientific research and for the simulation, analysis, and control of real time systems.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36 + 1 + 1
Binary digits/instruction	36 + 1 + 1
Instructions per word	1
Instructions decoded	64
Arithmetic system	Fixed point (Ones complement binary)
Instruction type	Indexable; Indirect addressing on all instructions
Number range	$-(1 - 2^{-35})$ to $(1 - 2^{-35})$

Instruction word format

1	1	5	6	6	1	17
meta bit	hold bit	configuration reg. no.	op code	Index register	indirect address bit	base address

All fixed programs are in toggle switch or plugboard storage.

Automatic coding includes standard compiler, which provides full symbolic coding facilities.

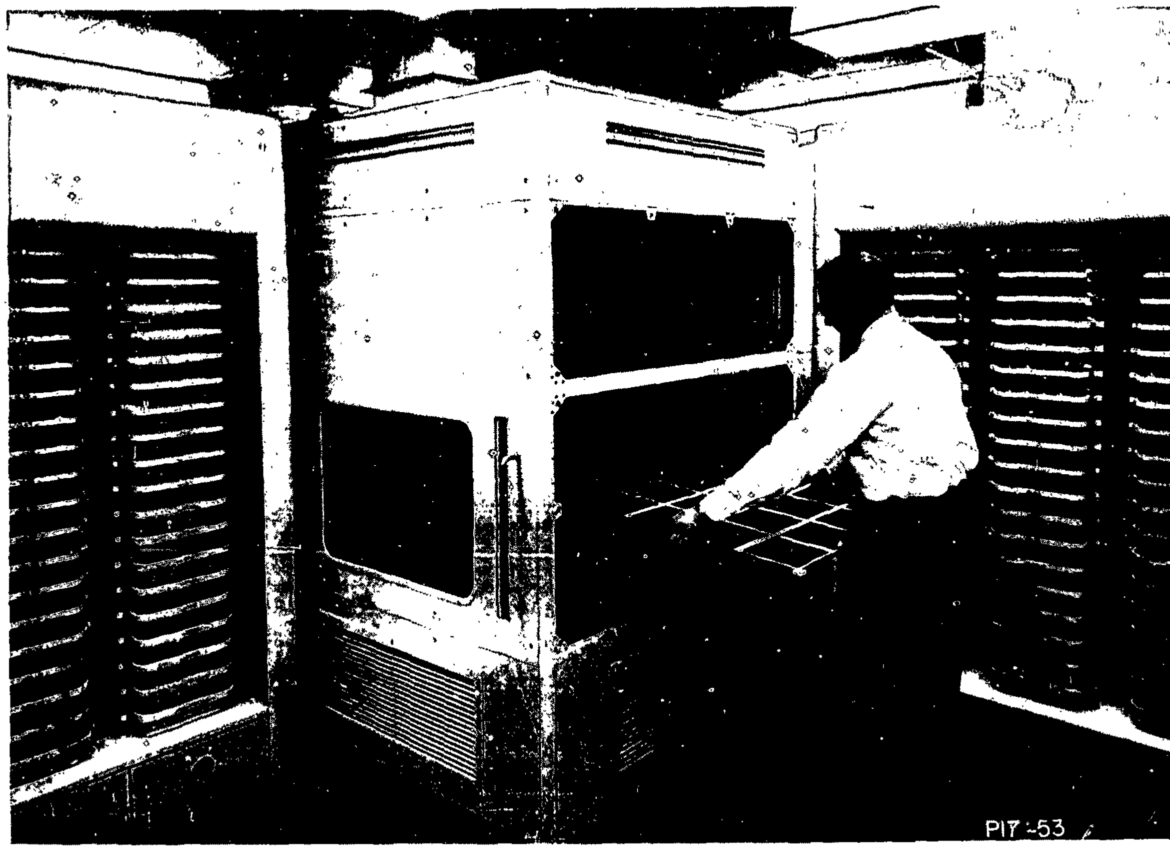
All four arithmetic registers and the exchange register are addressable as part of memory. There are sixty-four 18-bit parity-checked index registers.

Indirect addressing can be repeated indefinitely.

33 program (instruction) counters are provided, only one of which is used at a time.

Each in-out unit is associated with a program counter. Choice of program counter is determined by in-out unit, by program, and by relative priority of program counters.

Any instruction can specify a configuration of the computer during the execution of the instruction. A 36 bit operand word can be divided into one 36, one 27 and one 9, two 18, or four 9 bit subwords formed from the 9 bit quarters. The 9 bit quarters can be permuted among themselves. Any or all of the subwords can be used simultaneously. For example, two 18 bit multiplications are done by one multiply instruction in less than one 36 bit multiplication.



Memory Stall

Photo by Lincoln Laboratory, MIT

One bit of each computer memory word is used for parity checking. The other is used as a tag bit for program debugging.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	4.8	1.4
Mult	9.6 - 19.2	5 - 17 (9 bit-36 bit)
Div	19.6 - 80.0	17.2 - 75 (9 bit-36 bit)

Construction (Arithmetic unit only)	
Transistors	8,800
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

The following table lists the number of thousands of arithmetic operations of a given type which can be executed per sec.

Word Length in Bits		36	27	18	9
Arithmetic	+	200	200	400	800
Operation	x	50	67	17	400
	÷	13	17	48	200

STORAGE

Media	No. of Words	Read-Write Time	No. of Digits/Word	Microsec
Magnetic Core S Memory	65,536	6.4	36 + 1 + 1	3.4
Magnetic Core T Memory	4,096	4.4	36 + 1 + 1	2.2
Toggle switch, plugboard, etc	80	4.8	36 + 1	2.6
Magnetic Core Index Memory	64	3.4	18 + 1	0.6
Magnetic Film Config. Memory	32	0.8	9 + 1	0.3

Magnetic Tape

No. of units that can be connected	512 Units
No. of lines /er linear inch	330 Lines/inch
Channels or tracks on the tape	10 Tracks/tape
Blank tape separating each record	0 Inches
Tape speed	30-1000 Inches/sec
Transfer rate	3,300-37,500 Chars/sec
Start time	250 Millisec
Stop time	10,000-250 Millisec
Physical properties of tape	
Width	3/4 Inches
Length of reel	7,200 Feet
Composition	Mylar type 189 3M

Tape reels are not changed.

Fixed address system (like drum). Variable read speed.
32 tape unit drives can be treated as 10^{10}-bits of internal storage.
14" NARTB reel.
Recording channels are paired. One pair is used for timing marks, another for block marks, and the remaining three for information. Three lines of information form the standard unit of information, a 9 bit character.

INPUT

Media	Speed
Paper Tape	3000 7 bit lines/sec peak speed
Speed is not constant. Accelerates slowly compared to line width.	
Keyboard	10 6 bit char/sec
Lincoln Writer input	
Analog-Digital Converter	40,000 11 bit samples/sec
Epsco Datrac converter	
Light pen/eye	Manual
Signals selected by operator	
Random No. Gen.	18,000 9 bit words/sec
Radioactive source	
Miscellaneous Input	80 KC
9 channel pulse input to computer from miscellaneous devices.	

OUTPUT

Media	Speed
Paper Tape	180 7 bit lines/sec
Soroban punch	
Xerox printer	20 lines/sec 1300 char/sec
88 characters can be printed in 2 sizes. 6 bit vert. & 9 bit horiz. axes resolution.	
Typewriter	10 6 bit char/sec
Lincoln Writer output	
CRT point display & Camera	10 KC - 40 KC
10 bit resolution in both axes	
Miscellaneous output	Up to 500 cycles
9 channel switch for computer control of low rate devices	
Large board plotter	15 in/sec slew speed
PACE plotter	

Several input-output units can operate simultaneously so long as the time required by all the units operating does not saturate the central computer. Each unit has at most a single-line buffer; whenever a line of data needs to be transmitted to or from the central computer the unit causes the central computer to use its associated program counter. The machine can compute while in-out units are operating.

At peak rate, about 80,000 computer words/sec can be transferred into or out of the computer.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Use
Tubes		
6888	69	Clock pulse amplifiers
5998	312	S memory
Z-2177	296	S memory
Misc. Types	88	
Diodes		
CTP592	3,000	Input-output circuitry
1N625	736	Input-output circuitry
Misc. Types	1,488	Input-output circuitry
Transistors		
L5122	26,042	
L5134	31,928	
2N501	320	
2N357	1,016	
Misc. Types	2,227	
Magnetic Cores		
	2,490,880	S memory
	155,648	T memory
	2,432	X memory

All the vacuum tubes are used in the 65,536 word memory and in the generation of the computer clock pulses.

Resistor coupled transistor logic in the central computer operates at a 5 megapulse per second rate.

Thin magnetic film memory contains 320 magnetic spots.

CHECKING FEATURES

Checking features include a single bit odd parity check on all memories, a voltage margin check on all bias voltages, and a manual switching system selects circuits to be checked. A built-in sync system facilitates locating machine errors. A library of test programs are used which check the operation of the computer and which attempt to induce errors.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	20 Kw	25.6 KVA	0.8 pf
Power, air conditioner	17 Kw		
Area, computer	1,500 sq ft		
Area, air conditioner	350 sq ft		
Room size, computer	54 x 29		
Room size, air conditioner	17 x 20		
Capacity, air conditioner	25 Tons		

Cables run through overhead wireways. Air conditioning ducts also run overhead. An 8 ft high false ceiling is hung to cover these. Otherwise building is standard. Most power supplies are solid state. Principally required for memories.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

One-of-a-kind research computer

PERSONNEL REQUIREMENTS

Problem originators are trained to use the computer. Paper-tape preparation facilities and utility programs available to all computer users.

Three engineering assistants and one technician are available to do routine maintenance and to make changes in the computer system.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

As a research machine, TX-2 operating experience is good but though data is kept on machine failures, no reliability figures have been computed.

Basic circuits and components are similar to MIT's TX-0 machine.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include an operating thin magnetic film memory; 65,536 word magnetic core memory. Fixed address magnetic tape system. Multiple-sequence operation of computer and simultaneous operation of input-output units permits considerable flexibility in use of in-out units. Maximum execution time for any one arithmetic instruction can be reduced to one memory cycle time by overlapping instructions and memories.

Unique system advantages include multiple-sequence operation, configuration control over operands, thin magnetic film memory used in control element of computer, and 64 index registers stored in random access magnetic core memory.

The Lincoln Writer input-output unit permits considerable flexibility in communicating with the computer.

FUTURE PLANS

Another 4096 word magnetic core memory will be installed in order to increase opportunities for overlapping operation of memories.

A magnetic tape unit will be installed which will be compatible with units used on many commercial computers.

Input-output units will be added as the needs develop.

A new control console will replace the present console.

INSTALLATIONS

Lincoln Laboratory
Massachusetts Institute of Technology
P. O. Box 73
Lexington 73, Mass.

LITTON C 7000

Litton Industries, Model C 7000

MANUFACTURER

Litton Industries
Electronic Equipment Division

APPLICATIONS

System is designed for real time control systems applications requiring very high computing rates.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	21
Binary digits/instruction	21
Instructions per word	1
Instructions decoded	35
Arithmetic system	Fixed point Two's complement system of arithmetic is used
Instruction type	One address
Number range	-1 to $+1 - 2^{-20}$
Instruction word format	

00	01 06	07 09	10 20
Break-point	Operation Code	Index Tag	Address

Automatic built-in subroutines include square root and gray code to binary conversion.

Three index registers are included.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	4	2
Mult	26 (Average)	22
Div	46	42

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

Special hi speed multiplication technique is used. There is extensive overlapping in the execution of sequential instructions resulting in a very high speed computer.

STORAGE

Media	No. of Words	No. of Digits(Binary)	Microsec
Cores	1,280	28,160	4
Magnetic Drum	12,800	281,600	5,000 (Avg)

INPUT

Media	Speed
128 Word Drum Buffer	250 microsec avg to 1st word 4 microsec thereafter
Flexowriter	10 char/sec
Paper Tape	200 char/sec

OUTPUT

Media	Speed
512 Word Drum Buffer	1,000 microsec avg to 1st word 4 microsec thereafter
Flexowriter	10 char/sec

CHECKING FEATURES

Parity checks are built in on all core and drum memory transfer and storage. Program is automatically interrupted when error occurs and is detected.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.950 Kw
Volume, computer	9.5 cu ft
Area, computer	4 sq ft
Weight, computer	320 lbs

LITTON DATA ASSESSOR

MANUFACTURER

Litton Industries Data Assessor System

Electronic Equipments Division
Litton Industries

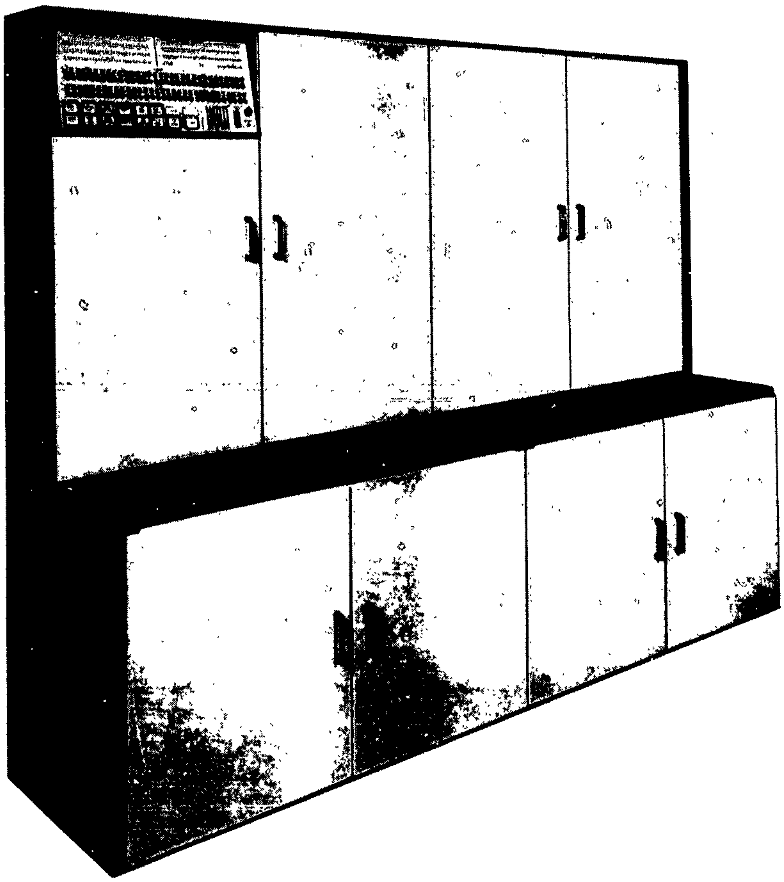


Photo by Litton Industries Electronic Equipments Division

APPLICATIONS

System is designed for general purpose computing and for special purpose problems, which take advantage of the internal information transfer in the computer. The useful characteristics are dual half word arithmetic (simultaneous operation on two half words), real time input-output functions, large amounts of data comparison, external control and communication, and computer-computer communication.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	32
Binary digits/instruction	32
Instructions per word	1
Instructions decoded	55
Arithmetic system	Fixed point

30 bits plus sign or two half words each of 15 bits plus sign

Instruction type	One address
Number range	Either $\pm (2^{30} - 1)$ or two half words of $\pm (2^{15} - 1)$

Input-output functions are automatic.

All B-box operations are included within each order. These include choice of B-box and whether the B-box itself should be modified.

Each command associated with information transfer contains stencil bits which allow full word, half word, or shifted half word transfer. In addition, it is possible to transfer a word logically multiplied by a stencil word.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	12	- 6
Mult	60-102	48-90 (half or full word)
Div	60-102	48-90 (half or full word)

A square root order is included. It takes 96 or 186 microseconds.

Construction (Arithmetic unit only)

Transistors	1,600
Diodes	17,000
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Cores	1,024	32	6
Drum	2,560	32	6-17,000

Up to eight independent magnetic tape units could be connected to the computer.

INPUT

Media	Speed
Data Link	750 bits/sec
Analog/Digital Converter	20 bits/6 microsec
Control Panel	

Link and converter are programmable.

OUTPUT

Media	Speed
Cathode Ray Tube	20 bits/6 microsec
Control Equipment	30 bits/6 microsec

Outputs are programmable. The input-output equipment specified is for a special purpose application. The input-output buffers can accept serial or parallel information up to a total maximum rate of 32 bits each 6 microseconds. The ability of each input buffer is programmable, but the various functions are controlled by the availability of external data.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM
FUTURE PLANS

Type	Quantity	
Diodes	23,000	
	1,000	memory
	16,000	logic
	6,000	clamps on the outputs or inputs of flip-flops or boosters or double inverters
Transistors	3,100	
	275	flip-flops at 4 each
	200	power boosters at 2 each
	800	double inverters at 2 each
Magnetic Cores	34,000	

The basic building blocks of the system are 4 transistor flip-flops, 2 transistor power boosters, and 2 transistor double inverters. In addition, there are several cards of fast adder carry propogation logic. The major number of cards in the system contain diode logic. There are numerous cards which are required for the mechanization of the core memory. Plans include provision of a separate memory for input -output to avoid interference with computation, additional memory modules, and geranium modules with silicon for wide ambient temperature range.

CHECKING FEATURES

There exists a parity bit in each word in core storage. If a parity bit failure occurs, or an incorrect order occurs, the error flip-flop turns on.
Program can be used to interpret error information. Under operator control, an error will either turn off the computer or cause the program to tally and classify such errors.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1.5 Kw	2.0 KVA	0.75 pf
Volume, computer		21 cu ft	
Area, computer		9 sq ft	
Room size		7 ft x 7 ft x 7 ft high (Suitable for Helihut use)	
Floor loading		60 lbs/sq ft	
Weight, computer		500 lbs	

The computer will work in an environment from 20°F to 100°F, and as such, no air conditioning was planned for the initial installation. Present system operates at 60 cps. A 400 cps model can be made available.

PRODUCTION RECORD

Number in current production	1
Number on order	1
Time required for delivery	6-8 months

PERSONNEL REQUIREMENTS

One operator is required for each shift. The present mechanization contains a self checking program and as it works on a real-time problem, it proceeds automatically. Because of this, a single operator is all that is required.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

ADDITIONAL FEATURES AND REMARKS

The design of the circuits is based upon very conservative techniques in order to assure a high degree of reliability. The worst-case method of analysis has been used to insure that the circuits operate satisfactorily while being subjected to the most adverse combination of component tolerances and parameter variations. In addition, all of the components have been derated with respect to allowable dissipation, voltage, etc. Component characteristics, such as current gain, are based upon history-derived estimate of the end-of-life value.

Provision is made in the Data Assessor for automatic checking. If a parity error should occur in the core memory, or if an incorrect order should be read, the appropriate error flip flop will turn on and this information would be entered into the computer. A switch on the control panel can be set to either stop the computer after an error, or allow the program to analyze the error. The program can be set to determine and tally the various types of errors. The program can then either correct them if they occur rarely or stop the computer and alert the operator if they occur often.

The Data Assessor is mechanized to provide all the error checking information necessary for complete error detection and checking. The amount of error checking performed depends on the type of program used. Outstanding features include self modifying B-box operation, built in stencil in each order, dual half word arithmetic, programmable (serial or parallel) input-outputs, alarm clock, and simplified communication between computer components. The computer operates at the rate of about 75,000 operations per second. Each operation can occur between two sets of independent variables, such as X, Y navigation. Inputs-outputs do not interrupt the program.

LOGISTICS

ONR ERA Logistics Computer

MANUFACTURER

Engineering Research Associates, Inc.

Photo by George Washington University

APPLICATIONS

Located at the Staughton Hall, 707 22nd Street, NW, Washington 7, D.C., the system is used for the numerical simulation of naval operations in the area of supply, mathematical studies in the area of matrix games, situations of attrition, and certain kinds of war game studies. System is also used directly as a research instrument in the development of concepts bearing upon data processing operations by the military.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Digits per word	12
Arithmetic system	Fixed point
Instruction type	Three address (approx)
Number range	$-(5.10^{11} - 1) \leqslant N \leqslant (5.10^{11} - 1)$
Instruction word format	

Normal mode of program storage is by way of wired instructions (many address) on a plugboard. A program may be stored internally and decoded by means of a control program wired on a plugboard. This latter method has been little used because of its low speed.

There are 15 registers.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec
Add	500
Mult	500 - 1000
Div	(Programmed division)

Construction (Arithmetic unit only)

Vacuum-Tubes	4,500
Condenser-Diodes	5,000
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

System is serial in decimal digits, parallel in bits for each decimal digit.

STORAGE

Media	No. of Words	No. of Dig/Word	Access Microsec
Magnetic Drum	var. 14,000-37,000	12-4	16,000
Magnetic Drum	7,000-80,000	60-4	16,000
High speed registers	15	12	220 Kc Shift rate

Total digit capacities of drums are about 185,000 and 400,000 respectively.

Second drum has usual read and write. The location or absence of a given word may be determined in one revolution by means of one of a system of SEARCH instructions.

INPUT

Media	Speed
Card (collator)	240 cards/min
Paper Tape	200 columns/sec

Paper tape input are Ferranti readers. Card rate is alternating from each of two pockets.

OUTPUT

Media	Speed
Card	50 cards/min
Paper Tape	60 char/sec two

Two paper tape outputs are teletype perforators.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	4,500
Diodes	5,000
Transistors	10,000
Magnetic Cores	3,240 (bits)

CHECKING FEATURES

Most commonly used checking feature is that machine will detect presence of non-numeric binary codes and will stop or branch.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

KVA, computer	19
KVA, air conditioner	22
Volume, computer	910 cu ft
Volume, air conditioner	130 cu ft
Area, computer	130 sq ft
Area, air conditioner	18 sq ft
Room size, computer and air conditioner	918 sq ft
Floor loading	7.4 lbs/sq ft 86 lbs concen max
Capacity, air conditioner	11 Tons

Computer was installed in a gutted area of building with heavy floor. Further ceiling support was provided. Motor generator set was installed in a small addition to main building. Building was an apartment house.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Cost/Price for basic system

Computer and one drum	$350,000
Ferranti readers and tape punches	4,000
Total	$354,000

Cost/Price for additional equipment

Input Output buffer	$ 95,000
Second drum (see above)	200,000

Computer and equipment cited is owned by Office of Naval Research.

Rental rates for additional equipment includes $200/ monthly for collator and punch used for Input-Output.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Analysts	3
Programmers	4
Clerks	2 keypunch operators
Engineers	2
Technicians	2

Operation tends towards open shop.

Method of training used is "write, load and debug."

Additional shift operations are filled in by programming staff or by the hiring on temporary basis of "computer Watchers" when tending is all that is required.

No increase in engineering staff would probably be required if we ran 2 shifts all the time.

Computer is capable of protracted good time.

Personnel cited above is approximation of relatively informal organizational setup.

The engineers cited are capable of work at all levels of electronic engineering and have extensively modified the original computer (delivery February 1953) both logically and in the matter of capacity of certain elements.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Good time	37 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.9

Above figures based on period 1 Jan 56 to 30 Jun 56

Time is available for rent to outside qualified organizations.

Our down time figures would indicate that our "would have run if computer were OK time" would be about 10% of our good time, hence the indicated ratio. During 1958 and 1959 a heavy modification program has reduced good time. Our current (last six months) good time is 16, with a somewhat lower operating ratio, i.e. 0.75.

ADDITIONAL FEATURES AND REMARKS

The search logic as noted above. Given that a certain register contained the word w, one or another of the search instructions would determine its absence, the address of its location)somewhere), or of its "next" location, or of its "first" location in about 16 milliseconds.

FUTURE PLANS

A new adder is being built for this machine.

The operation is serial and digital addition will occur every two drum (shift) clocks instead of during the 7 now used.

Division, 11 decimal digits divided by 11 decimal digits plus signs will be installed.

INSTALLATIONS

The George Washington University
Logistics Research Project
707 22nd Street, N. W.
Washington 7, D. C.

MAGNEFILE B

Magnefile Electronic Data Processing System B

MANUFACTURER

Electronics Corporation of America
Business Machines Division

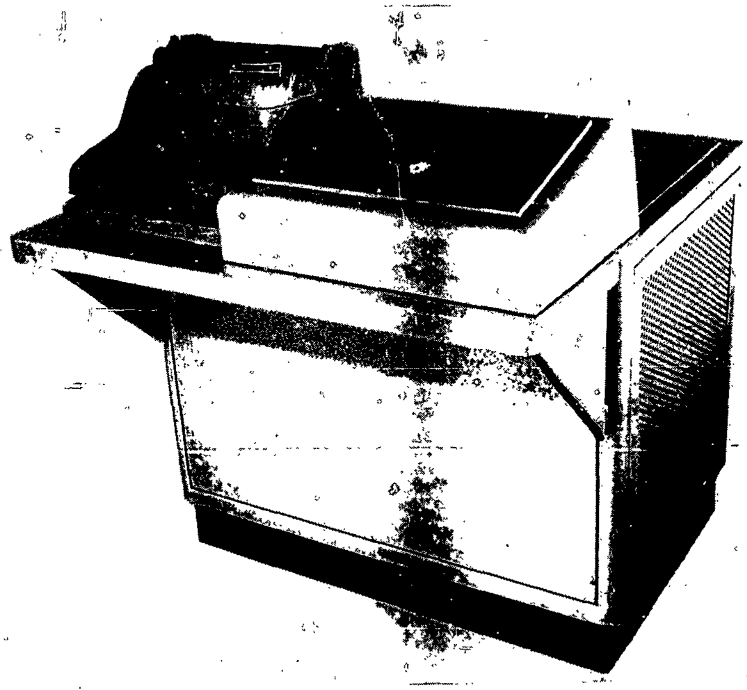


Photo by Electronics Corporation of America

APPLICATIONS

Inventory control for retail sales department store.
Special purpose, no longer in production.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Decimal
Decimal digits/word	8
Instructions/word	Instructions wired in
Instructions used	7
Arithmetic system	Fixed point
Instruction type	One address

Three addresses are entered simultaneously.

ARITHMETIC UNIT

Add time (exclud stor access)	150,000 microsec
Construction	Vacuum tubes
Basic pulse repetition rate	30 Kc/sec
Arithmetic mode	Serial
Timing	Asynchronous
Operation	Sequential

STORAGE

Medium	Words	Access Microsec
Magnetic Drum	4,040	300,000

INPUT OUTPUT

Medium	Speed
Full Keyboard	4 char/sec
Typewriter	7 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	130	6 Types
Crystal diodes	40	
Different plug-in units	10	
Separate cabinets	1	

CHECKING FEATURES

Continuous checking total

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.6 Kw
Area, computer	3.5 ft x 2.5 ft
Weight, computer	400 lbs

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $20,000.

PERSONNEL REQUIREMENTS

One operator required during operation. A service technician is called when needed.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Passed Customer Acceptance Test 15 February 1954.

INSTALLATIONS

B. Altman and Company
Fifth Avenue
New York, New York

MAGNEFILE D

Magnefile Electronic Data Processing System Model D

MANUFACTURER

Electronics Corporation of America
Business Machines Division

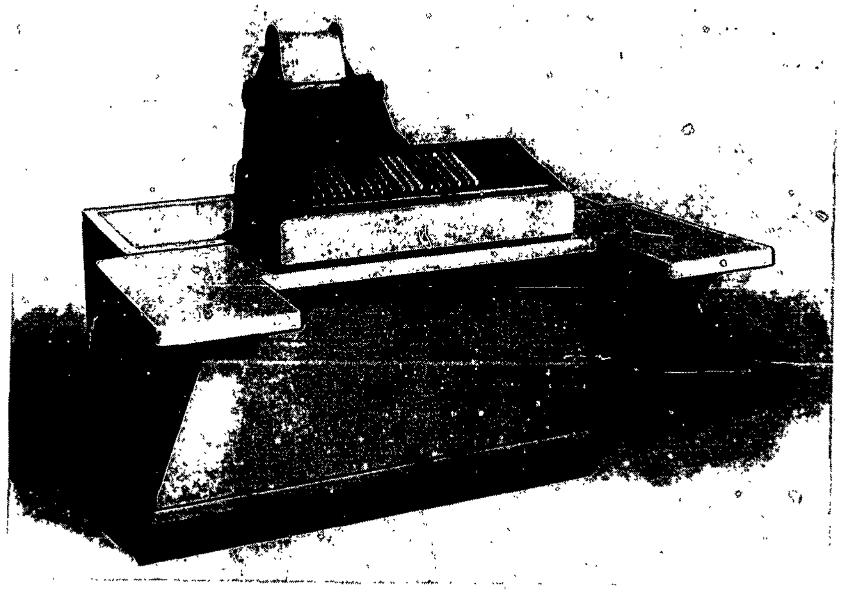


Photo by Electronics Corporation of America

APPLICATIONS

Inventory control. No longer manufactured.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Decimal
Decimal digits/word	42
Instructions/word	Instructions wired in
Instructions used	77
Arithmetic system	Fixed point
Instruction type	One address

Three one-address commands are entered simultaneously.

ARITHMETIC UNIT

Add time (exclud stor access)	100,000 microsec
Construction	Vacuum tubes
Basic pulse repetition rate	40 Kc/sec
Arithmetic mode	Serial
Timing	Asynchronous
Operation	Sequential

STORAGE

Media	Words	Access Microsec
Magnetic Drum	8,000	50,000
Magnetic Drum	500	50,000

The larger drum stores 8,000 21 dec dig words.
The smaller drum stores 500 42 dec dig words.

INPUT OUTPUT

Media	Speed
Full Keyboard	Manual (4 char/sec)
Typewriter	10 char/sec

Remote keyboards may be added.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	140	4 Types
Crystal diodes	240	
Different plug-in units	12	
Separate cabinets	1	

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1 Kw
Area, computer	5 ft x 3 ft
Weight, computer	700 lbs

PRODUCTION RECORD

Number produced 1
No longer in production

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $50,000. No longer in production.

PERSONNEL REQUIREMENTS

One operator. On call technician.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Passed Customer Acceptance Test 5 August 1953.

INSTALLATIONS

B. Altman and Company
Fifth Avenue
New York, New York

MANIAC I

Mathematical Analyzer Numerical Integrator and
Computer Model I

MANUFACTURER

University of California
Los Alamos Scientific Laboratory

Photo by University of California, Los Alamos Scientific Laboratory

APPLICATIONS

University of New Mexico Research Center
Located at University of New Mexico Research Center, 2206 Lomas Blvd., N.E. (Box 181), albuquerque, New Mexico, the system is used for general purpose scientific computations, providing a computer service to faculty and students of the university.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	40
Binary digits/instruction	8
Instructions per word	2
Instructions decoded	36
Binary digits/instruction not decoded	2
Instructions used	35
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-1 \leq n < 1$

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add time	80
Mult time	1,000
Div time	1,000
Construction	Vacuum tubes
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Concurrent

STORAGE

Media	Words	Access Microsec
Electrostatic (CRT)	1,024	8 - 16
Magnetic Drum	10,000	50 words in 83,000

Cathode Ray Tube is of the Williams type.

INPUT

Media	Speed
Paper Tape	1,024 words in 48 seconds
Magnetic Tape	1,024 words in 45 seconds

OUTPUT

Media	Speed
Printer (Teletype)	36 words/min
Printer (Anelex)	3,600 words/min
Paper Tape	81 words/min
Magnetic Tape	1,024 words in 45 seconds

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	2,400
Tube types	7
Crystal diodes	500
Different plug-in units	1 Electrostatic
	6 Magnetic Drum
Separate cabinets	4

Type 2BP1 cathode ray tubes (Williams) are used in the storage unit.

CHECKING FEATURES

Check sum on filling storage by paper tape and magnetic tape.
Check sum on filling magnetic drum.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

University of California

Power, computer	35 Kw
Volume, computer	128 cu ft
Area, computer	20 sq ft
Capacity, air conditioner	10 Tons

U of New Mexico

Site preparation include channeled floor for air conditioning and power, ceiling ducts for air conditioning, and a special room for the motor-generators (D.C. supply).

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $250,000.
Approximate cost of high speed printer and magnetic drum $48,000.
Prices include development, construction and overhead.

PERSONNEL REQUIREMENTS

U of New Mexico

System is to be operated and maintained by one person. It is expected to be operating prior to 1 Jan 1961 at the University of New Mexico.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

U of New Mexico

Average error-free running period	5 Hours
Good time	11,493 Hours
Attempted to run time	12,399 Hours
Operating ratio (Good/Attempted to run time)	0.93

Above figures based on period from Mar 52 to Jan 57
Passed Customer Acceptance Test Mar 52
Time is available for rent to outside organizations.
The machine was moved to the University of New Mexico in 1958. Installation was started in 1959.

FUTURE PLANS

U of New Mexico

The machine is being studied by approximately six graduate students at the Master of Science level, with three masters thesis being written on proposed system changes, including, replacing the single channel tape system with a multi-channel system, a logical study of a program interchange between MANIAC I and a NATIONAL 102A, and modifications to the existing adder in the machine.

INSTALLATIONS

University of New Mexico
Research Center
2206 Lomas Blvd. N.E.
Albuquerque, New Mexico

MANIAC II

Mathematical Analyzer Numerical Integrator and Computer Model II

MANUFACTURER

University of California
Los Alamos Scientific Laboratory

Photo by University of California, Los Alamos Scientific Laboratory

APPLICATIONS

University of California, Los Alamos Scientific Laboratory
Located at Los Alamos, N. M., the system is used for studies in automatic programming, symbolic manipulations (e.g., algebra, differential calculus), mathematics, esp. combinatorial and algebraic transformations, Monte Carlo, crystallography, and general applied mathematics.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	48
Binary digits/instruction	24
Instructions per word	2
Instructions decoded	94
Arithmetic system	Fixed and floating point
Instruction type	One address
Number range	2^{112}

Instruction word format

1	2 8	9 10	11 24
Break Point	Order	Index	Address

Automatic coding includes MADCAP (86 characters, full sub- and superscripting). Display quotients are planned.
Registers and B-boxes include 3 B-boxes, a universal register, a storage register and a remainder register.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Mult	180 avg	180 avg
Div	300 avg	300 avg

Construction (Arithmetic unit only)

Vacuum tubes	2,850
Diodes	1,040

Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Bin Dig/Word	Access Microsec
Cathode Ray Tube (Barrier Grid)	12,288	49	15 (avg)
Magnetic Cores	4,096	49	2.4

Magnetic Tape

No. of units that can be connected	3 Units
No. of chars/linear inch of tape	300 Char/inch
Channels or tracks on the tape	1 Track/tape
Blank tape separating each record	6 Inches
Tape speed	60 Inches/sec
Transfer rate	18,000 Char/sec
Start time	25 Millisec
Stop time	30 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.25 Inch
Length of reel	1,200 Feet
Composition	1 1/2 mil mylar sandwich

Two physical tracks on tape combine to form a single information channel.

INPUT

Media	Speed
Magnetic Tape	270 words/sec
Paper Tape	250 char/sec
Keyboard	Manual

OUTPUT

Media	Speed
Magnetic Tape	270 words/sec
Printer	77,400 char/sec (max)
Punch	60 char/sec
Electric Typewriter	10 char/sec

Printer speed is 900 lines/min.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	5,190
Diodes	3,050
Transistors	1,160
Magnetic Cores	200,700

95% of the tubes are Type 5965. 5% are high power drives.

CHECKING FEATURES

Parity check on electrostatic storage and magnetic tape.
Load sums for identification
(+) Exponent spill
Overflow
(-) Exponent spill

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	37 KVA
Volume, computer	1,000 cu ft
Area, computer	150 sq ft
Capacity, air conditioner	15 Tons

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

The total cost is about $350,000.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Supervisors	3
Analysts	4
Programmers	8
Coders	2
Clerks	1
Operators	1
Engineers	4
Technicians	4

Operation tends toward open shop.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	Several Hours
Good time	50 Hours/Week (Average)
Attempted to run time	52 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.96

Above figures based on period from 1958 to present
Time is not available for rent to outside organization.

ADDITIONAL FEATURES AND REMARKS

3 indexing registers (B registers) for automatic; address modification and cycle counting (independent of arithmetic elements).

Semi-automatic exit from sub-routines.

Large base for floating point operation to increase speed of floating point additions.

"Madcap", Mathematical and Descriptions Coding Assembly Program, will translate a series of logical and algebraic statements into a computer ready code, this will use a seven hole tape, standard coding uses five holes. Tape reader can handle either.

INSTALLATIONS

University of California
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico

MANIAC III

Mathematical Analyzer Numerical Integrator and Computer

MANUFACTURER

University of Chicago
Institute for Computer Research

APPLICATIONS

This system will be used by all interested departments of the University of Chicago.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	48
Instructions per word	1
Instructions decoded	94
Arithmetic system	Floating point
Instruction type	Two address
Number range	
Fraction range	$(1 - 2^{-39})$ to -1
Exponent range	+127 to -127

Instruction word format

1	7	1	5	14	1	5	14
Tag	Operation	Inflector	Modifier	Address	Inflector	Modifier	Address

Registers and B-boxes
- 3 Arithmetic Registers
- 8 Transistor Storage Registers
- 8 Index Registers
- 2 Indicator Registers

Four different types of arithmetic (significant digit floating point, specified point, normalized, basic), all using same number format (exponent-fraction).

Special exponent used to denote absolute zero (essentially zero with exponent -(x).

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	24 + n/2	18 + n/2
Mult	71	65
Div	81	75

n = difference of exponents.

Construction (Arithmetic unit only)

Transistors	10,000
Condenser-diodes	16,000
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Concurent

STORAGE

No. of Words	No. of Digits	Access Microsec
8,192	48	1

Plans in progress to include an additional 8,192 words.

Magnetic Tape

No. of units that can be connected	4 Units
No. of char/linear inch of tape	250 Char/inch
Channels or tracks on the tape	8 Tracks/tape
Blank tape separating each record	5 Inches
Tape speed	150 Inches/sec
Transfer rate	37,500 Char/sec
Start time	5 Millisec
Stop time	5 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,500 Feet
Composition	Mylar

INPUT

Media	Speed
Paper Tape	350 char/sec
Keyboard (Typewriter)	Manual Alphabetic and numeric
Magnetic Tape	37,500 char/sec

OUTPUT

Media	Speed
Paper Tape	60 char/sec
Typewriter	10 char/sec
Line Printer	600 lines/min
Magnetic Tape	37,500 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	20,000
Transistors	12,000
Magnetic cores	500,000

CHECKING FEATURES

Parity on tapes and core storage.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	2 Kw	2 KVA	1.0 pf
Area, computer		64 sq ft	
Room size, computer		25 ft x 30 ft	
Floor loading		50 lbs/sq ft max	
		20 lbs/sq ft	
		50 lbs concen max	
Weight, computer		600 lbs	

Room temperature controlled to 75°F., humidity 40% - 60%. Cable ways under floor, or false floor.

PERSONNEL REQUIREMENTS

Open shop policy.

ADDITIONAL FEATURES AND REMARKS

All arithmetic performed on operands in exponent-coefficient form; several options for sealing of result allow calculation to be performed, "generalized fixed point", "normalized", significance-mode, or multiple-precision as convenient.

INSTALLATIONS

University of Chicago
Institute for Computer Research
Chicago 37, Illinois

MERLIN

MERLIN

MANUFACTURER

Brookhaven National Laboratory

APPLICATIONS

Located at Upton, New York, the system is used for Atomic Energy Commission programs, including areas of physics, chemistry, biology, medicine, reactor studies, acceleration design and meteorology.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number of binary digits per word	48
Number of binary digits per instruction	48
Number of instructions per word	1
Number of instructions decoded	Approx 90
Arithmetic system	Floating point Fixed point
Instruction type	One address (mostly) Two address (some)
Number range	$2^{-120} - 2^{120}$

Instruction word format

Y	Z	b	b'	m	m'

YZ = command (two hexadecimal characters)
b } B box address for 1st address, 2nd address
b') (4 bits each)
m 1st memory address (16 bits each)
m' 2nd memory address

Automatic built-in subroutines
Square-root

Registers and B-boxes
6 B-boxes
3 shifting and 4 non-shifting registers, the latter for fast access storage, in Arithmetic Section
Pathfinder for subroutine return
16 bit Sense Register

48 bit word has one multi-address instruction. The numerical operand represents number in the form 2^{8e} X: four bits specify magnitude of exponent e, one bit its sign; 40 bits the magnitude of the fractional part X and one bit its sign. Of the remaining two bits of the word (tag bits), one may be automatically detected by control. Fetching of next sequenced instruction begins before completion of operation. MERLIN is patterned after MANIAC II (Los Alamos).

ARITHMETIC UNIT

	Incl. Stor. Access Microsec.	Exclud. Stor. Access Microsec.
Add	8 μs (3.5)	-
Mult.	140 μs	130
Div.	330 μs	320

Construction, arithmetic unit only

Type	Quantity
Vacuum tubes	
5956	800
6197	275
Diodes	
T3G	7,000

Arithmetic mode Parallel

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Electrostatic Barrier Grid Tube	8,192	49	6

INPUT

Media	Speed	
Flexowriter	10 char/sec	Friden
Paper Tape	200 char/sec	Ferranti TR 2
Magnetic Tape	20K char/sec	Ampex FR 300 - 4 units

OUTPUT

Media	Speed	
Flexowriter	10 char/sec	Friden
Paper Tape	60 char/sec	Teletype
Magnetic Tape	20K char/sec	Ampex FR 300
Printer	10 lines (96 char)/sec	Shepard

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	
Tubes		
5965	2,500	Blocking Osc. Flip Flops and Cathode followers
6197	400	Pulse Drivers
12E1	18	Deflection Amplifiers and Pulse Amps.
OA2	24	Regulators
Diodes		
T3G	16,000	Gating and Switching
T5G	350	Gating and Switching
IN643	150	Gating and Switching
Zenor Diodes		
Various	40	Bias Supplies
Transistors		
2N247	400	Memory Read Amplifier and Buffer
2N393	100	Memory Discriminator
2N344	300	Memory Strobe and Parity
2N1091	20	Emitter Followers
Magnetic Cores		
Various	1,200	Blocking Oscillator and Pulse Transformers

CHECKING FEATURES

Parity check at input/output and memory output. Single bit error correction to be added at memory output.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	40 Kw	45 KVA	0.9 pf
Power, air conditioner	16 Kw	18 KVA	0.9 pf
Volume, computer		1500 cu ft	
Area, computer		165 sq ft	
Room size, computer		1400 sq ft	
Volume, air conditioner		150 cu ft	
Area, air conditioner		25 sq ft	
Room size, air conditioner		1200 sq ft	
Capacity, air conditioner		20 Tons	

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Cost	$600,000

PERSONNEL REQUIREMENTS

	One 8-Hour Shift Used
Supervisors	1
Analysts	2
Programmers	7
Clerks	1
Engineers	2
Technicians	3

Operation tends toward open shop.

Formal two week course (1 1/2 hr/day). Individual assistance as required.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Time is available for rent to outside organizations on a qualified basis.

Operating figures are not yet available.

Computer is in final stages of debugging and is available on a limited basis.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include 4 fast access temporary storage registers.

FUTURE PLANS

An additional 8000 words of Radechon memory will be incorporated with a self-correcting code. An 8000 word magnetic core memory will also be added.

Modifications, including specialized input-output equipment, will be undertaken on the basis of specific research requirements.

INSTALLATIONS

Brookhaven National Laboratory
Upton, New York

MINIAC II

MINIAC II

MANUFACTURER

Marchant Calculators, Incorporated
(Now Smith-Corona Marchant, Inc.)
Data Processing Systems Division

Picture by The Atlantic Refining Company, Incorporated, Dallas, Texas

APPLICATIONS

The Atlantic Refining Company
Scientific and engineering. Utilized by the Atlantic Refining Company's Research and Development Department for research and development in oil exploration and production. Scientific and engineering applications include synthetic seismograms, geophone responses, chemical process designs and fluid flow in porous media.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Bin coded and Hexa dec
Digits per word	10 decimal
Digits per instruction	10 decimal
Instructions per word	1
Instructions decoded	71
Arithmetic system	Fixed point
Instruction type	One address

ARITHMETIC UNIT

	Includ. Stor. Access Microsec Average	Includ. Stor. Access Microsec Maximum	Exclud. Stor. Access Microsec
Add time	11,200	21,200	450
Mult time	24,300	41,400	13,600
Div time	25,600	43,200	14,800

Construction	Vacuum tubes
Basic pulse repetition rate	300 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous (clocking channels on the drum)
Operation	Sequential

The add time, excluding storage access, given above, is equivalent to 3 word times. The operand and instruction times are included in all the above values.

STORAGE

Media	Words	Digits	Microsec Access
Magnetic drum	4,096	10 plus sign	1,200-10,000

256 words, 2,500 microsec average access, is optional.

INPUT

Media	Speed
Paper Tape (Flexowriter)	600 char/min (6 channel tape)
Ferranti Photoelectric Reader	300 words/min (limited by loading program)
Keyboard	Manual

OUTPUT

Media	Speed
Paper Tape (Flexowriter)	600 dig/min
Friden Punch	30 char/sec (6 channel)

Spare Flexowriter can also be used for the separate preparation of data and programs.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	850
Tube types	7 cover 95%
Crystal diodes	2,000
Separate cabinets	1

There are 75 types of plug-ins at $10 each.
50% of the machine uses 7 types of plug-ins.
The major types of tubes are the 5963, 5687, 12BH7, 12AT7, 5965, 5915, 2D21.
A cold water supply and a desk for the Flexowriter is included.

CHECKING FEATURES

Timing circuits
Twenty jacks for applying marginal voltages

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	5 KW, 220 volt
Space, computer	91 cu ft, 20 sq ft
Space, air cond.	Dimensions 4.5 x 4.5 x 4.5 ft plus desk
Weight, computer	2,000 lbs
Capacity, air cond.	2 tons

Designed for cooling by water between 60° and 65°F.

PRODUCTION RECORD

Produced	1 Model C and 1 Model II
Operating	1 Model C and 1 Model II
Delivery time	No longer manufactured

COST, PRICE AND RENTAL RATES

Approximate cost of basic system	$85,000
Approximate cost of Flexowriter	$ 2,950
Approximate cost of Spare Flexowriter	$ 2,950

No maintenance contract.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	Used	Recom	Used	Recom	Used	Recom
Operators	1	1	1	2	1	2
Typist	0	1	0	1	0	1

Methods of training used On the Job

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Good time	42 Hours/Week
Attempted to run time	48 Hours/Week
Operating ratio (Good/Attempted to run time)	0.875

Above figures based on period from 26 Feb 60 to 26 Mar 60
Acceptance test 1 Mar 55
Time is not available for rent to outside organizations.

Magnetic drum replaced in 1958.

Converted from one-address to two-address operation in 1959.

FUTURE PLANS

Incorporation of a Moseley system, to have the following items:
- Tape Translator
- X-Y Recorder
- Character Printer
- Curve Follower

INSTALLATIONS

Atlantic Refining Company
Research and Development Laboratory
4500 W. Mockingbird Lane
Dallas, Texas

MISTIC

Michigan State Digital Computer

MANUFACTURER

Michigan State University

Photo by Michigan State University

APPLICATIONS

Service facility for University staff and students on an open shop basis for general purpose computation.

Used for instructional purposes in several programming and numerical analysis courses which are offered for credit by the University.

Available for use on applicable sponsored research projects.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number of binary digits per word	40
Number of binary digits per instruction	20
Number of instructions per word	2
Total number of instructions decoded	186, of which 139 are unique
Arithmetic system	Fixed point
Instruction type	One-address
Number range	-1 to $+(1-2^{-39})$

Instruction word format

ORDER		ADDRESS	ORDER		ADDRESS
Type	Variant		Type	Variant	
4 bits	4 bits	12 bits	4 bits	4 bits	12 bits

Two 40-bit shifting registers and one 40-bit fixed register for arithmetic operations.

Two separate 2-bit registers will hold a bank address for 16,384 word core memory, one register each for operands and instructions.

ARITHMETIC UNIT

Operation, Incl stor. access	Microseconds
Add time	100
Mult time	1,000
Div time	1,100
Excl stor. access	
Add time	80
Mult time	980
Div time	1,080

Construction (Arithmetic unit only)

Vacuum tubes type	Quantity
5844	580
7044	236
5670	120

Arithmetic mode Serial

STORAGE

Media	Number of Words	Digits per Word	Access Microseconds
Cathode Ray Tube	1,024	40 bin	20
Magnetic Core	16,384	40 bin	20

The MC memory will replace the CRT memory.

INPUT

Media	Speed
5-level Photodiode Paper Tape	300 char/sec
Cards	200 cards/min

Above speeds are maximum. Card decoding is programmed so that input is 100 cards/minute for most applications.

OUTPUT

Media	Speed
Paper Tape	60 char/sec
Teletypewriter	10 char/sec
Cards	100 cards/min, max

Cards are program decoded.
CRT output is under construction.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes

Type	Quan
5844	1,300
5670	650
7044	400
5726	100
Misc.	160
Total	2,610

CHECKING FEATURES

Division algorithm automatically checks for overflow and division by 0.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	18.5 K.W., input to computer
Power, air conditioner	10 K.W., including fan, water pump and cooling tower fan
Volume, computer	500 cu ft
Volume, power supplies	200 cu ft
Volume, air conditioner	150 cu ft
Volume, cooling tower	320 cu ft
Area, computer	75 sq ft
Area, power supplies	30 sq ft
Area, air conditioner	32 sq ft
Area, cooling tower	32 sq ft
Room, computer	12 ft x 18 ft
Room, power supplies	8 ft x 9 ft
Air conditioner	10 Horsepower

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

PERSONNEL REQUIREMENTS

Typical Personnel	One 8-Hour Shift
Supervisors	1
Analysts	2
Programmers	2
Clerks	1
Librarians	1
Operators	1
Engineers	1
Technicians	1

The computer is operated on an open-shop basis so that most of the functions other than direct operation and maintenance of the computer are taken care of by the various users.

INSTALLATIONS

Michigan State University
East Lansing, Michigan

FUTURE PLANS

A 40-bit 16,384 word core memory is under construction and will replace the existing 1,024 word CRT memory in the Fall of 1960.

A CRT output with an attached camera is also under construction which will permit analog output directly from the computer. This will be made available in the Fall of 1960.

MOBIDIC A

Mobile Digital Computer A AN/MYK-1(v)

MANUFACTURER

Sylvania Electric Products, Incorporated

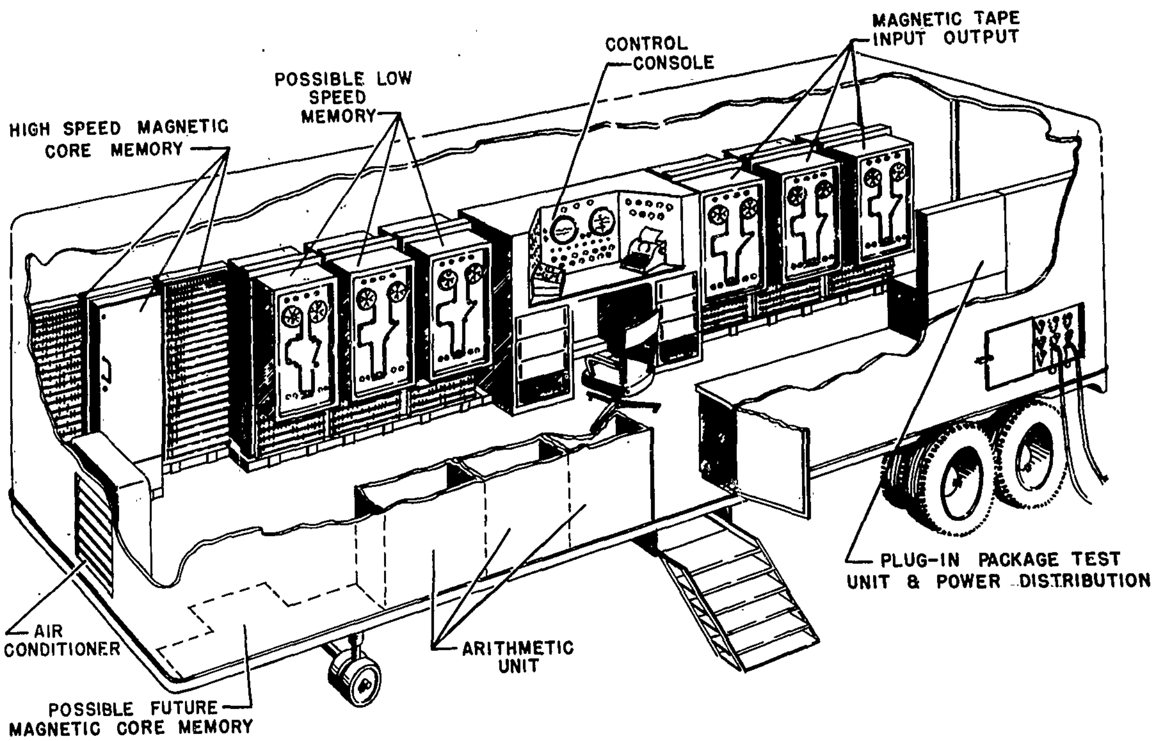


Photo by Sylvania Electric Products, Inc.

APPLICATIONS

Presently located at the Needham Industrial Park, the MOBIDIC "A" is a mobile, highly-reliable, high speed, general purpose computing facility for use by field commanders for combat support data processing, combat control data processing, combat computation, and logistic computations.

The Real Time System consist of Real Time Input-Output registers, both of which are capable of communicating with an external device (including another MOBIDIC) over nine lines (6 data, 1 parity, 2 control). The Input system incorporates a program interupt feature.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36 plus sign & parity bits
Binary digits/instruction	36 plus spare & parity bits
Instructions per word	1
Instructions decoded	52
Arithmetic system	Fixed point

Assumed binary point at left end of word, between bits 36 & 37

Instruction type	One address

Some instructions are two address, e.g. load, move, etc.

Number range	$-(1 - 2^{-36})$ to $+(1 - 2^{-36})$

Instruction word format

Standard Computer Instruction Word

38	37	36 31	30 28	27 16	15 13 12 1
Parity	Spare	Op. Code	Index Reg. Selection	Minor Address	Major Address

Input-Output Instruction Word

38	37	36 31	30 22	21 16	15 13 12 1
Parity	Spare	In-Out Comd	Word-Block Counter	Device Selection	Storage Address

Automatic coding includes the Mobidic Assembly Program.

Registers include 6 in the Central Processor, 4 Index, 2 in the Communications Converter, and 2 in the In/Out Converter.

Instructions consist of 15 Arithmetic, 8 Transfer, 17 Logical, 3 Sense, and 9 Input-Output instructions.

Index Registers are expansible to a total of 7.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	16	8
Mult	86	78
Div	88	88

Construction (Arithmetic unit only)

Transistors	6,000
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

Mostly sequential, however processing may proceed during input-output operations.

STORAGE

Media	No. of Words	No. of Bits/word	Access Microsec
Core Memory (2)	4096 each	40	8

Expandable to a total of 7 memories.

Magnetic Tape

No. of units that can be connected	63 Units
No. of chars/linear inch of tape	300 Chars/inch
Channels or tracks on the tape	8 Tracks/tape
Blank tape separating each record	1.5 Inches
Tape speed	150 Inches/sec
Transfer rate	45,000 Chars/sec
Start time	1.5 Millisec
Stop time	1.5 Millisec
Average time for experienced operator to change reel	120 Seconds
Physical properties of tape	
Width	1/2 Inches
Length of reel	3600 Feet
Composition	1 mil mylar

The 40 bit word length in storage is made up of:

36 bit magnitude
1 bit sign
1 bit parity
1 busy-bit
1 spare-bit
40 Total in storage

INPUT

Media	Speed
Paper Tape 5 channel 11/16 inch tape	200 char/sec (start-stop) to 270 char/sec
Paper Tape 8 channel 1 inch tape	200-270 char/sec
Real Time Channel character by character	120,000 char/sec
Cards	200 cards/min

The Real Time System was designed to operate with the Collins Kineplex equipment whose speed is 300 characters/sec. or with another MOBIDIC; however, it can operate with any compatible transmission equipment.

OUTPUT

Media	Speed	
Paper Tape 5 channel	100 char/sec	11/16" tape
Paper Tape 8 channel	100 char/sec	1 inch tape
Real Time	120,000 char/sec	char by char
Flexowriter	10 char/sec	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
SG-225	6,000
Transistors	
2N393	32,000
Magnetic Cores	311,200

CHECKING FEATURES

Checking features include parity on memory transfer and input-output, overflow, non-existant memory, non-existant instruction, and non-existant device (I/O). Marginal checking may also be performed. Diagnostic Routines to check the machine and indicate instruction which fail and aid in the localization of failures are available.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	29.76 Kw	37.2 KVA	0.8 pf
Power, air conditioners	4.64 Kw	5.8 KVA	0.8 pf
Volume, computer	1,440 cu ft		
Area, computer	240 sq ft		
Floor loading	300 lbs/sq ft		
	240 lbs concen max		
Volume, two air conditioners	72 cu ft		
Area, two air conditioners	48 sq ft		
Capacity, two air conditioners	6 Tons		
Weight, computer	12,000 lbs		
Weight, air conditioners	1,200 lbs		

The computer is mounted in a 30 foot van, air conditioning ducts on the right and left ceilings, and the heater duct at floor level behind the I/O converters, Central Processor, and memory units.

Air-conditioning is for operator comfort only.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	18 months

System is being tested and evaluated.

COST, PRICE AND RENTAL RATES

Large computer system such as this one is seldom duplicated from one installation to another. Individual problem and application normally requires unique configuration and special features that establish either purchase or lease price. Upon completion of a feasibility study when the requirements are known, along with a calculated growth, costs could be determined.

PERSONNEL REQUIREMENTS

Training will be dependent on the requirements of the user. However, it is recommended that personnel have a minimum of 4 weeks of formal class room lectures followed, if possible, by closely supervised on-the-job-training.

Number of operating personnel will depend on the requirements of the user.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include ruggedization for field use. System operates between -25°F to 125°F and 0 to 97% relative humidity. It is built on a modular basis, expansible in memory (to 7), I/O converter (up to 4), and I/O equipment (to 63).

Unique system advantages include containment in 240 sq ft. It is a completely mobile, large scale, general purpose system. System is designed for reliability, mobility, flexibility, fixed plant, and strategic installation, with minimum space requirements, and minimum pre-installation cost, such as air conditioning and power. This machine is a member of the Army FIELDATA Family of Computers. It uses the FIELDATA code and is compatible with other FIELDATA machines.

INSTALLATIONS

One MOBIDIC will be installed for the 7th Army Stock Control Center in Germany. Other systems will be installed to cover a wide range of applications.

MOBIDIC B

Mobile Digital Computer B AN/MYK-2(v)

MANUFACTURER

Sylvania Electric Products, Incorporated

APPLICATIONS

The MOBIDIC B is a duplexed general purpose computer being developed for inclusion into a tectical army operation center. The machine's mechanized instruction list was selected for optimized operation in the processing of data rather than for scientific calculations. The two machines may be synchronized together and run as one machine or they may be used separately.

The MOBIDIC B has two real time in-out registers and possible sources of such real time data are radar equipment, weather stations, drone aircraft and other MOBIDICS. This computer is also suited for applications such as message switching centers. One processor receives the incoming message and does the incoming processing and then stores the message in the common mass memory. The second processor would serve as the output message processor, taking the message from the common mass memory completing the processing and transmitting it out. If one machine failed, the second could handle the work at a reduced system speed.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36 plus sign bit & parity
Binary digits/instruction	36 plus spare bit & parity
Instructions/word	1
Instructions decoded	55 + 9 special subroutine instructions
Arithmetic system	Fixed point

Assumed binary point at left end of word, between bits 36 and 37

Instruction type	One address

Some instructions are two address, e.g. load, move, etc.

Number range $-(1 - 2^{-36})$ to $+(1 - 2^{-36})$

Instruction word format

38	37	36 31	30 28	27 16	15 13 12 1
Parity	Spare	Op. Code	Index Reg. Selection	Minor Address	Major Address

Standard Computer Instruction Word

38	37	36 31	30 22	21 16	15 13 12 1
Parity	Spare	In-Out Comd	Word-Block Counter	Device Selection	Storage Address

Input-Output Instruction Word

Automatic coding includes MOBIDIC Assembly Program.

Registers include 8 in the central processor, 2 in the communications converter, 2 in the In/Out Converter and 7 index registers.

Instructions consist of 15 Arithmetic, 9 Transfer, 18 Logical, 3 Sense, 10 Input-Output, and 9 Special instructions.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	42	34
Mult	88	80
Div	Not mechanized	

Construction (Arithmetic unit only)

Transistors	6,000
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Bits/word	Access Microsec
Magnetic Core	8,192		8
Disk	6.25×10^6	8	1×10^6

Expansible to a total of 7 core memories of 4,096 words each

Magnetic Tape

No. of units that can be connected	63 Units
No. of chars/linear inch of tape	300 Chars/inch
Channels or tracks on the tape	8 Tracks/tape
Blank tape separating each record	1.5 Inches
Tape speed	150 Inches/sec
Transfer rate	45,000 Chars/sec
Start time	1.5 Millisec
Stop time	1.5 Millisec
Average time for experienced operator to change reel	120 Seconds
Physical properties of tape	
Width	1/2 Inches
Length of reel	3,600 Feet
Composition	1 mil mylar

INPUT

Media	Speed
Paper Tape 5 channel 11/16 inch tape	200 char/sec (start-stop) 270 char/sec
Paper Tape 8 channel 1 inch tape	200-270 char/sec
Real Time Channel character by character	120,000 char/sec
Cards	200 cards/min

The Real Time System was designed to operate with the Collins Kineplex equipment whose speed is 300 characters/sec. or with another MOBIDIC; however, it can operate with any compatible transmission equipment.

OUTPUT

Media	Speed	
Paper Tape 5 channel	100 char/sec	11/16" tape
Paper Tape 8 channel	100 char/sec	1 inch tape
Real Time	120,000 char/sec	char by char
Flexowriter	10 char/sec	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type		Quantity
Diodes		
SG225		6,000
Transistors		
2N393	Approx.	30,000
Magnetic Cores		655,360

CHECKING FEATURES

Checking features include parity on memory transfer and input-output, overflow, non-existant memory, non-existant instruction, and non-existant device (I/O). Marginal checking may also be performed. Diagnostic Routines to check the machine and indicate instruction which fail and aid in the localization of failures are available.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	34.2 Kw	42.75 KVA	0.8 pf
Power, air conditioner	6.6 Kw	8.25 KVA	0.8 pf
Volume, computer		690 cu ft	
Volume, air conditioner		72 cu ft	
Area, computer		115 sq ft	
Area, air conditioner		48 sq ft	
Weight, computer		12,600 lbs	
Weight, air conditioner		1,200 lbs	
Capacity, air conditioner		Two at 1.5 Tons each	

Air conditioners are for personnel comfort only

Computer is mounted in a 30 ft van and a shelter of approximately the size of an S-109.

PRODUCTION RECORD

Number in current production	1
Number on order	1
Time required for delivery	18 months

ADDITIONAL FEATURES AND REMARKS

Outstanding features include reggedization for field use. System operates between -250°F to +125°F and 0 to 97% relative humidity. It is built on a modular basis, expansible in memory (to 4), I/O converter (up to 4), and I/O equipment (to 63).

Unique system advantages include containment in 335 sq ft. It is a completely mobile, large scale, general purpose system. System is designed for reliability, mobility, flexibility, fixed plant, and strategic installation, with minimum space requirements, and minimum pre-installation cost, such as air conditioning and power. This machine is a member of the Army FIELDATA Family of Computers. It uses the FIELDATA code and is compatible with other FIELDATA machines.

The 40 bit word length in storage is made up of:

36 bit magnitude
1 bit sign
1 bit parity
1 busy-bit
1 spare-bit
40 Total in storage

MOBIDIC C D & 7A

Mobile Digital Computer C, D, 7A AN/MYK-1(v)

MANUFACTURER

Sylvania Electric Products, Incorporated

APPLICATIONS

MOBIDIC C, D, and 7A are mobile highly reliable, high speed, general purpose computing systems for use by the field commanders for combat support data processing, combat control data processing, combat computations and logistic computations.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36 plus sign & parity bits
Binary digits/instruction	36 plus spare & parity bits
Instruction per word	1
Instructions decoded	52
Arithmetic system	Fixed point

Assumed binary point at left end of word, between bits 36 & 37

Instruction type	One address

Some instructions are two address, e.g. load, move, etc.

Number range $-(1 - 2^{-36})$ to $+(1 - 2^{-36})$

Instruction word format

Standard Computer Instruction Word

38	37	36 31	30 28	27 16	15 13 12 1
Parity	Spare	Op. Code	Index Reg. Selection	Minor Address	Major Address

Input-Output Instruction Word

38	37	36 31	30 22	21 16	15 13 12 1
Parity	Spare	In-Out Comd	Word-Block Counter	Device Selec-tion	Storage Address

Automatic coding includes the Mobidic Assembly Program.

Registers include 6 in the Central Processor, 4 Index, 2 in the Communications Converter, and 2 in the In/Out Converter.

Instructions consist of 15 Arithmetic, 8 Transfer, 17 Logical, 3 Sense, and 9 Input-Output instructions.

Index registers are expansible to a total of 7.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	16	8
Mult	86	78
Div	88	80

Construction (Arithmetic unit only)

Transistors	6,000
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

Operation is primarily sequential, however processing may proceed duting input-output operations.

STORAGE

Medium	No. of Words	No. of Bits/word	Access Microsec
Magnetic Core	2 ea (4096) total 8192	40	8

Expansible to a total of 7 magnetic core memories of 4,096 words each.

Magnetic Tape

No. of units that can be connected	63 Units
No. of chars/linear inch	300 Chars/inch
Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	1-1/2 Inches
Tape speed	1-150 Inches/sec
Transfer rate	300-45,000 Chars/sec
Start time	3 Millisec
Stop time	3 Millisec
Average time for experienced operator to change reel	120 Seconds
Physical properties of tape	
Width	1 Inch
Length of reel	3,600 Feet
Composition	Mylar

MOBIDIC C & MOBIDIC D each have (8) tape units while MOBIDIC 7A has 11.

INPUT

Media	Speed
Paper Tape 5 channel 11/16 inch tape	200 char/sec (start-stop) to 270 char/sec
Paper Tape 8 channel 1 inch tape	200-270 char/sec
Real Time Channel character by character	120,000 char/sec
Cards	200 cards/min

OUTPUT

Media	Speed	
Paper Tape 5 channel	100 char/sec	11/16" tape
Paper Tape 8 channel	100 char/sec	1 inch tape
Real Time	120,000 char/sec	
Flexowriter	10 char/sec	char by char

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
SG225	6,000
Transistors	
2N393	30,000
Magnetic Cores	335,872

MOBIDIC is a completely Solid State computer

CHECKING FEATURES

Parity on memory transfer and input-output, over flow, non-existant memory, non-existant instruction, non-existant device (I/O), marginal checking, and diagnostic programs to check the machine and indicate instructions which fail and aid in the localization of failures.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	44.8 Kw	56 KVA	0.8 pf
Power, air conditioner	9.28 Kw	11.6 KVA	0.8 pf
Volume, computer		2,880 cu ft	
Volume, air conditioner		72 cu ft	
Area, computer		480 sq ft	
Area, air conditioner		48 sq ft	
Weight, computer		7,000 lbs	
Weight, air conditioner		600 lbs ea	
1200 lbs - Total for 1 van			
2400 lbs - Total for 2 vans			
Capacity, air conditioner		1 1/2 Tons	
		18,000 BTU/hr each	

No special site requirements. MOBIDIC C, D, 7A are mounted in two 30' vans. KVA & Kw ratings include air conditioning for two vans. Kw and KVA maximum for entire system. Air conditioning is for operator comfort only. Air conditioners are two per van. All figures are for two vans.

PRODUCTION RECORD

Number produced to date	1 - AN - MYK - 1(v)
Number in current operation	1
Number in current production	3
Time required for delivery	18 months

ADDITIONAL FEATURES AND REMARKS

Outstanding features include reggedization for field use. System operates between -25°F to +125°F and 0 to 97% relative humidity. It is built on a modular basis, expansible in memory (to 7), I/O converter (up to 4), and I/O equipment (to 63).

Unique system advantages include containment in 480 sq ft. It is a completely mobile, large scale, general purpose system. System is designed for reliability, mobility, flexibility, fixed plant, and strategic installation, with minimum space requirements, and minimum pre-installation cost, such as air conditioning and power. This machine is a member of the Army FIELDATA Family of Computers. It uses the FIELDATA code and is compatible with other FIELDATA machines.

The 40 bit word length in storage is made up of:

36 bit magnitude
1 bit sign
1 bit parity
1 busy-bit
1 spare-bit
40 Total in storage

MODAC 404

Mountain Systems Digital Automatic Computer

MANUFACTURER

Airborne Instruments Laboratory, Incorporated (Parent)
Mountain Systems, Incorporated

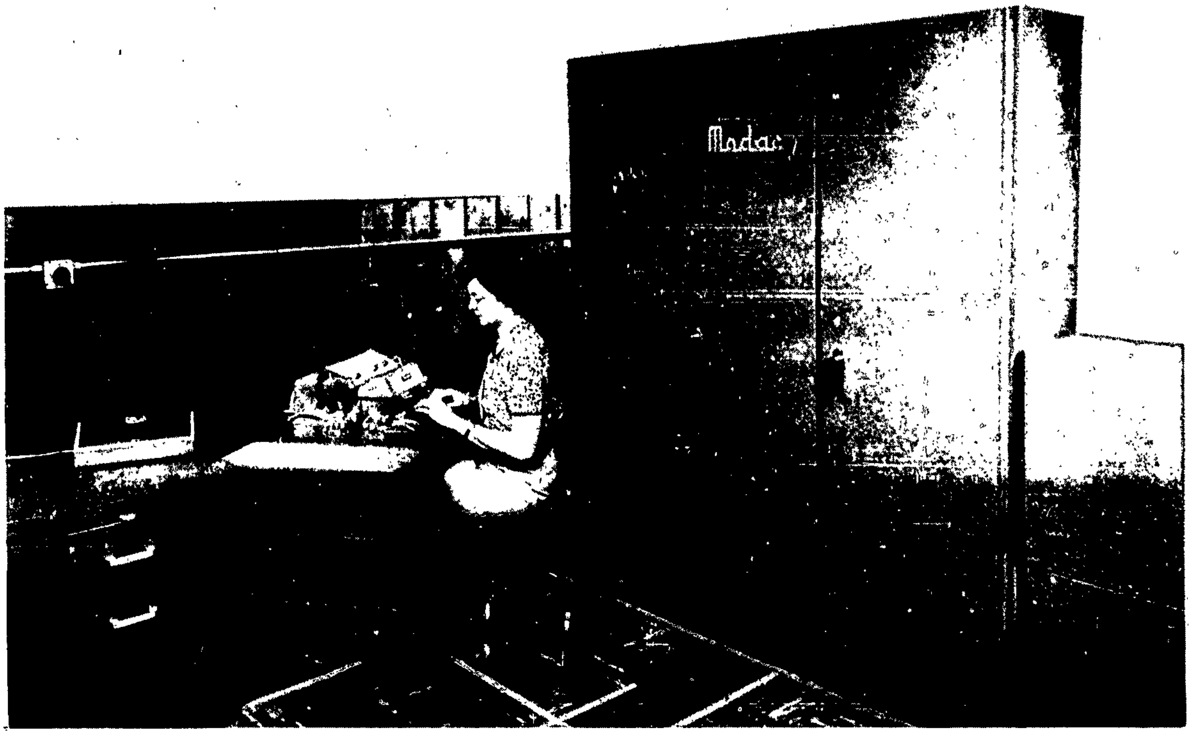


Photo by Reader's Digest Association

APPLICATIONS

Statistical and business data processing, accounting, coding and controls.
System is no longer being manufactured.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	6
Decimal digits/instruction	2
Instructions decoded	8
Arithmetic system	Fixed point
Instruction type	One address
Number range	0 to 999,999

Programming system is designed for special application. Operations include addition, subtraction, unit entry, bulk entry and transfer.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add time	25,000	240

Construction	Vacuum tubes
Basic pulse repetition rate	150 Kc/sec
Arithmetic mode	Serial
Timing	Asynchronous
Operation	Sequential

The addition time given above is for the addition of two 6-digit decimal numbers.

STORAGE

Medium	Words	Digits	Access Microsec
Magnetic Drum	20,000	120,000	25,000

Access time given above is average. System stores 500,000 binary digits in 50 milliseconds access time.

Photo by Reader's Digest Association

INPUT

Media	Speed
Paper Tape	200 char/sec
Punched Cards (Rem. Rand Tab)	4 cards/sec

OUTPUT

Media	Speed
Paper Tape	200 char/sec
Punched Cards (Rem. Rand Tab)	4 cards/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	1,000
Tube types	3
Crystal diodes	2,000
Separate cabinets	1

CHECKING FEATURES

Address check

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	3 Kw
Volume, computer	120 cu ft
Area, computer	20 sq ft
Weight, computer	1,500 lbs

PRODUCTION RECORD

Reader's Digest Association

Number produced	1
Number in operation	1

COST, PRICE AND RENTAL RATES

Reader's Digest Association

Approximate cost of basic system $100,000.
System is no longer in production.

PERSONNEL REQUIREMENTS

Reader's Digest Association

Daily Operation	Engineers	Tech and Operators
One 8-hour shift	0	1

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Reader's Digest Association

Good time	6,000 Hours
Attempted to run time	6,188 Hours
Operating ratio (Good/Attempted to run time)	0.97

Figures based on period from Sep 55 to Jan 57
Passed Customer Acceptance Test Sep 54

Additional features include external programming, dual entry to memory with single address and an address check.

System no longer manufactured.

MODAC 410

Mountain Systems Digital Automatic Computer Model 410

APPLICATIONS

Business data processing.
System is no longer being manufactured.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Decimal - Excess 3
Decimal digits per word	10
Arithmetic system	Fixed point
Instruction type	One address
Number range	0 to 10 decimal digits

Program is stored internally and on tape.

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add time	600
Mult time	7,000
Div time	7,000
Construction	Vacuum tubes, magnetic elements and diodes
Rapid access word registers	50
Basic pulse repetition rate	150 Kc/sec
Arithmetic mode	Serial
Timing	Asynchronous
Operation	Sequential

Computer is serial with buffer storage.

STORAGE

Medium	Words	Access Microsec
Magnetic Drum	5,000	7,500

50,000 decimal digits stored.
Buffer storage in magnetic cores.

INPUT

Media	Speed
Punched Tape	400 char/sec
Punched Cards	600 cards/min

OUTPUT

Media	Speed
Punched Tape	60 char/sec
Punched Cards	600 cards/min

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	600
Tube types	3
Crystal diodes	3,000
Magnetic elements	1,000
Number of different plug in units	5
Number of separate cabinets	2

MANUFACTURER

Airborne Instruments Laboratory, Incorporated
Mountain Systems Incorporated

CHECKING FEATURES

Number checks
Address checks
Odd number check

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	4 Kw
Volume, computer	40 cu ft
Area, computer	20 sq ft
Weight, computer	1,000 lbs

PRODUCTION RECORD

Number produced	1
Number in operation	1

System out of production.

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $120,000.
Price includes input and output equipment described.
Other equipment dependent upon specific application.
System is no longer being manufactured.

PERSONNEL REQUIREMENTS

One operator required during operation.

ADDITIONAL FEATURES AND REMARKS

Special translator or converter feature reads an abbreviation on a punched card, looks up corresponding code from a list of 5,000 and punches a code number into the same card at a reading and punching rate of 500 per minute.

High speed tallying feature performs 1,440,000 unit additions per hour into selected registers.

Transactions, from a total of 4,000 categories, can be read at random and added to an appropriate one of 4,000 registers.

System no longer being manufactured.

INSTALLATIONS

Readers Digest Association, Incorporated
Condensed Book Club
Pleasantville, New York

MODAC 414

Mountain Systems Digital Automatic Computer Model 414

MANUFACTURER

Airborne Instruments Laboratory, Incorporated (Parent)
Mountain Systems, Incorporated

APPLICATIONS

Reader's Digest Association, Incorporated
Large scale translation; statistical processing and general purpose computation.
System is no longer being manufactured.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal and alphanumeric
Decimal digits/word	6
Decimal digits/instruction	2
Instructions decoded	12
Arithmetic system	Fixed point
Instruction type	One address (for general purpose applications)

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add time	8,000	288
Mult time	8,000	8,000
Div time	8,000	8,000

Construction	Vacuum tubes and magnetic cores
Arithmetic mode	Serial
Timing	Asynchronous
Operation	Sequential Concurrent for punched cards in any of three modes.

The multiply and divide times given above include re-record time.

STORAGE

Media	Words	Characters	Access Microsec
Magnetic Drum	6,000	36,000	8,000
Magnetic Drum	4	24	576
Magnetic Cores	2	12	288

INPUT

Media	Speed
Punched Cards	360 cards/min
Paper Tape	

Paper tape is used for report programming and testing.

OUTPUT

Media	Speed
Punched Cards	360 cards/min
Paper Tape	20 char/sec

Punched cards are used for translation and paper tape for reports.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	2,000 (approx)
Tube types	3 (major)
Crystal diodes	3,000 (approx)
Magnetic cores	396

CHECKING FEATURES

Odd-even checks on numerical calculations are used.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	5 Kw
Volume, computer	240 cu ft
Area, computer	40 sq ft
Weight, computer	3,000 lbs

PRODUCTION RECORD

Number produced	1
Number in operation	1

System is no longer being manufactured.

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $150,000.
System is out of production.

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
One 8-hour shift	0	2

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Passed Customer Acceptance Test October 1956.
System is no longer being manufactured.

INSTALLATIONS

Reader's Digest Association, Incorporated
Condensed Book Club
Pleasantville, New York

MODAC 5014

Mountain Data Processor Model 5014

MANUFACTURER

Airborne Instruments Laboratory, Incorporated (Parent)
Mountain Systems, Incorporated

Photo by Airborne Instruments Laboratory, Inc.

APPLICATIONS

Manufacturer
Business data processor. System no longer being manufactured.

Hickok Manufacturing Company, Incorporated
A perpetual inventory, furnishing reports to the Central Planning and Packaging Departments.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20
Binary digits/instruction	60
Arithmetic system	Decimal-binary
Instruction type	One address, consisting of two parts. Address "A" selects a magnetic drum read-record head and address "B" selects a particular location on the drum.
Number range	"A" ranges from 0 to 66 "B" ranges from 0 to 150

ARITHMETIC UNIT

		Microsec
Add time (Includ stor access)		32

Construction	Vacuum tubes, using a combination of trigger pairs, pullers, and cathode followers. A crystal diode matrix is also used.
Arithmetic mode	A combination series-parallel shift register is utilized.
Timing	Synchronous
Operation	Sequential

Three types of pulses are used to control operation. Serial feed is by use of 5 channel paper tape. Basic operations are addition, subtraction and "reading out" a balance.

STORAGE

Media	Words	Digits	Access Microsec
Magnetic Drum	10,000	50,000	
Shift Register	1	5	32
Paper Tape			

Paper tape is utilized for permanent storage in order to release the magnetic drum for other purposes.

The magnetic drum is 8 inches long and 7 inches in diameter. There are 66 recording heads. The address system is composed of a relay pyramid and an electronic counter.

INPUT

Medium	Speed
Paper Tape	600 char/min

Above tape is 5-channel tape, which is prepared by an IBM 063 Card-to-Tape Converter or a Flexowriter typewriter.

OUTPUT

Medium	Speed
Paper Tape	600 char/min

Direct to paper tape or via a Flexowriter typewriter.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	535
Tube types	8
Crystal diodes	150
Separate cabinets	4

Crystal diode types used are the 1N35 and the 1N116. Tube types used are the 5965, 5915, 6AN5, 12BH7, 12AX7, 2D21, 5963, and 6AS6. All four cabinets are inter-cabled.

The IBM 063 Card-to-Tape Converter and the Flexowriter are located in an adjoining room. The Flexowriter can be cabled directly to the computer so as to print out in hard copy as the computer is in operation.

CHECKING FEATURES

Checking is performed by using predetermined "heads" and "spots" on the drum and tapes with known answers. A visual check is made.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Volume, computer	120 cu ft
Area, computer	16 sq ft
Four cabinets	2 x 2 x 7.5 ft each
Weight, computer	600 lbs

COST, PRICE AND RENTAL RATES

Hickok Manufacturing Company, Inc.

Approximate cost of basic system	$85,000
Approximate cost of Flexowriter	1,200

Rental rates of IBM 063 Card to Tape Converter ($65.00 plus $6.50 tax)/month.

System is no longer manufactured.

PERSONNEL REQUIREMENTS

Hickok Manufacturing Company, Inc.

One operator and 1 clerk are utilized to operate the system on a one 8-hour shift/week basis. One engineer is utilized for developing methods and procedures.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	30 Hours
Good time	145 Hours/Week
Attempted to run time	168 Hours/Week
Operating ratio (Good/Attempted to run time)	0.87

Figures based on the last three years.

Passed Customer Acceptance Test July 1954

System is no longer being manufactured.

INSTALLATIONS

Hickok Manufacturing Company, Incorporated
Rochester, New York

MONROBOT III

Monroe Computer Model III

MANUFACTURER

Monroe Calculating Machine Company
Electronics Division

Photo by Monroe Calculating Machine Company, Electronics Division

APPLICATIONS

Air Force Cambridge Research Center
Scientific calculation.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	20
Decimal digits/instruction	10
Instructions per word	1
Instructions decoded	11
Instructions used	11
Arithmetic system	Fixed point
Instruction type	Four address
Number range	$10^{-10} \leq n \leq 10^{10} - 1$

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add time	120,000
Mult time	540,000
Div time	540,000
Construction	Vacuum tubes
Basic pulse repetition rate	10 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	Words	Access Microsec
Magnetic Drum	100 numbers	15,000
Magnetic Drum	100 instructions	15,000

INPUT

Media	Speed
Keyboard	Manual
Paper Tape	10 dig/sec

OUTPUT

Media	Speed
Typewriter (Flexowriter)	10 dig/sec
Paper Tape (Flexowriter)	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	800
Tube types	4
Crystal diodes	100

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	2.5 Kw
Space, computer	Desk size
Weight, computer	1,000 lbs

PRODUCTION RECORD

Number produced 1
No longer in production.

PERSONNEL REQUIREMENTS

One technician or mathematician is required to operate system.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Good time	28 Hours
Attempted to run time	35 Hours
Operating ratio (Good/Attempted to run time)	0.80
Figures based on period 1 Feb 55 to 1 Sep 56	
Passed Customer Acceptance Test	1 Feb 55

Approximately 1 hour/day is required for maintenance, therefore "attempted to run time" is considered to be 40-5, or 35 hours.

INSTALLATIONS

Air Force Cambridge Research Center
Computing Laboratory
Cambridge 39, Massachusetts

MONROBOT V

Monroe Computer Model V

MANUFACTURER

Monroe Calculating Machine Company
Electronics Division

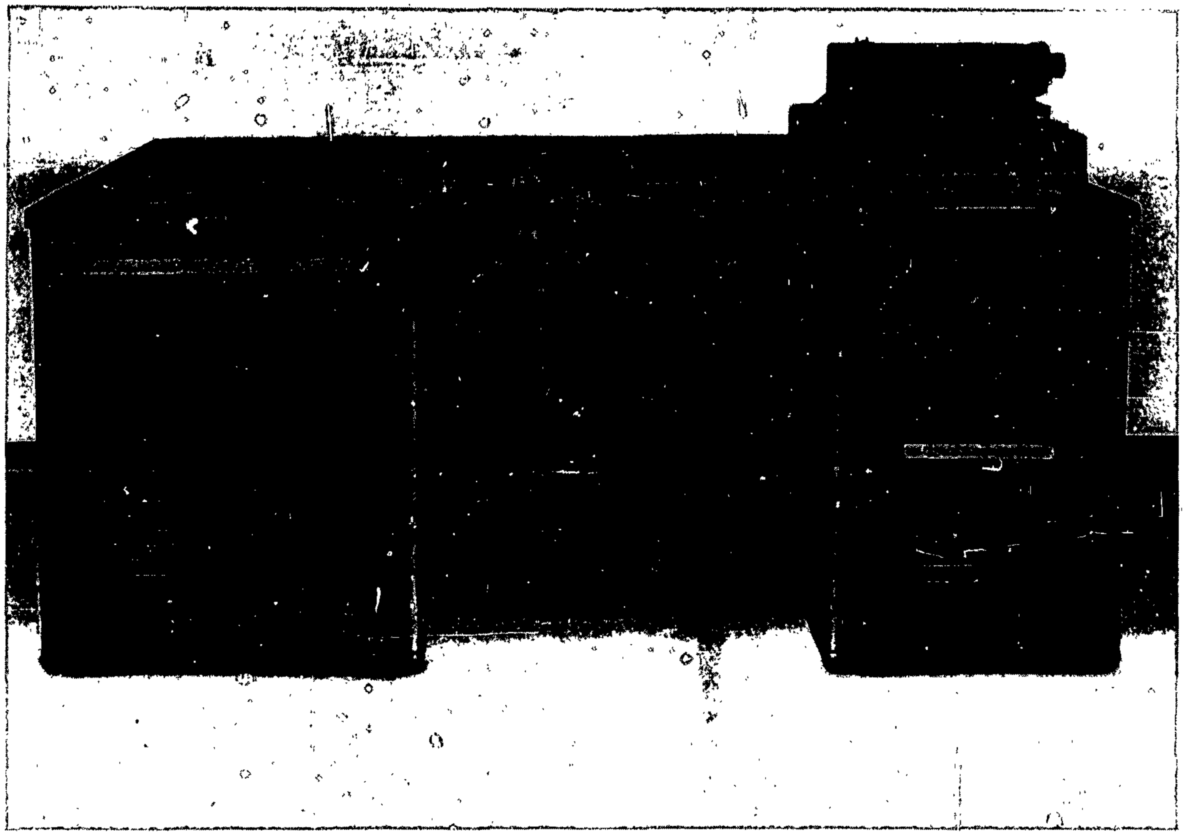


Photo by Monroe Calculating Machine Company, Electronics Division

APPLICATIONS

Computing problems normally encountered by Topographic Troops in surveying operations.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	20
Decimal digits/instruction	10
Arithmetic system	Fixed point
Instruction type	Four address

ARITHMETIC UNIT

	Includ Stor Access Microsec
Add time	120 (approx)
Mult time	540 (approx)
Div time	540 (approx)
Construction	Vacuum tubes
Basic pulse repetition rate	10 Kc/sec
Timing	Synchronous
Operation	Sequential

STORAGE

Media	Words	Access Microsec
Magnetic Drum	300	18,000
Paper Tape		

Access time on drum is for 100 twenty digit numbers. Drum is 6 inches in diameter, 20 inches long and rotates at a speed of 3,550 rev/min.

INPUT

Media	Speed
Keyboard	Manual
Paper Tape (Reader)	570 char/min

OUTPUT

Medium	Speed
Typewriter (Flexowriter)	Reader 570 char/min
	Printer 400 char/min

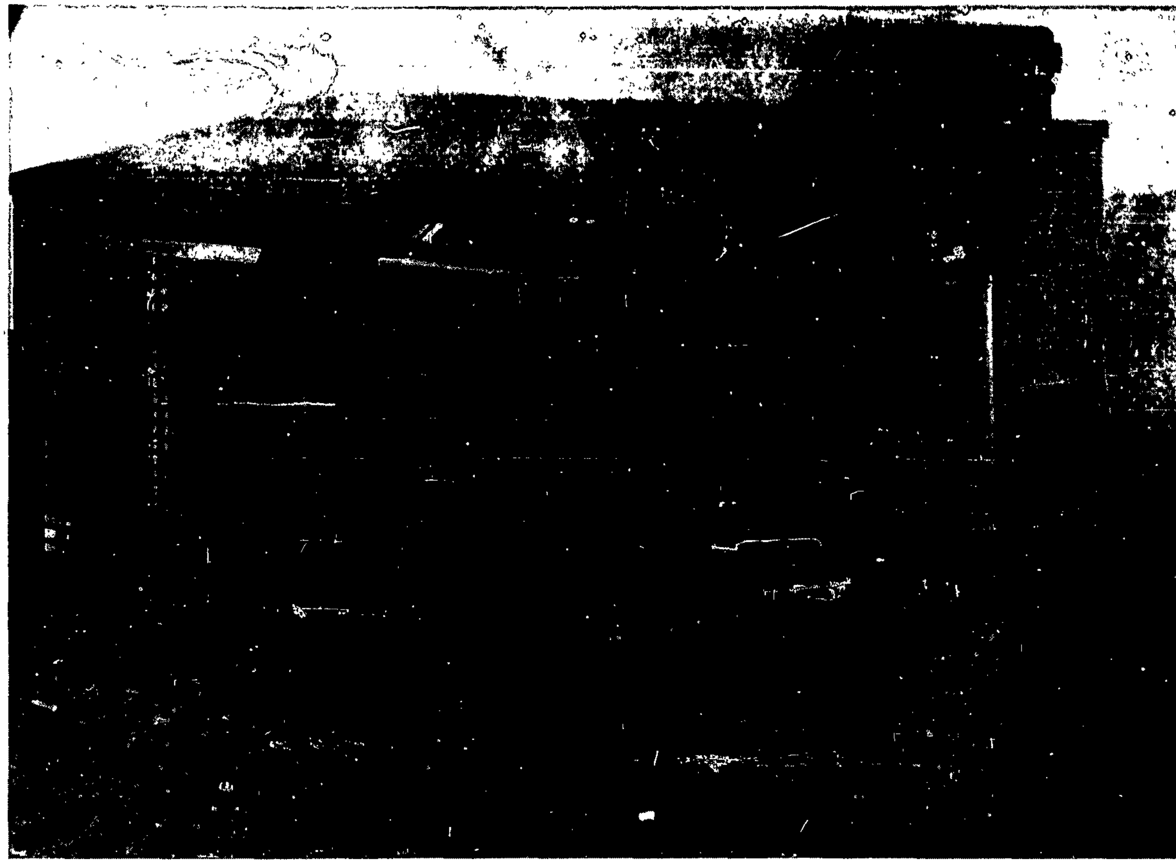


Photo by U. S. Army Corps of Engineers, Engineer Research and Development Laboratories

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	800 (approx)
Crystal diodes	1
Tube types	5814A, 5726, 5751, 5844, 6005, and 5725

CHECKING FEATURES

Storage selection indicators.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	5 Kw
Area, computer	44 1/2 in x 72 in x 31 in Desk
Weight, computer	1,686 lbs, including Flexowriter

PRODUCTION RECORD

Number produced 1
No longer in production.

COST, PRICE AND RENTAL RATES

Manufacturer
System is no longer being manufactured.
Engineer Research and Development Laboratories
Approximate cost of basic system $86,074.

PERSONNEL REQUIREMENTS

Engineer Research and Development Laboratories
One person required for operation and one person required for servicing unless one person is trained to perform both operation and servicing.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Operating ratio (Good/Attempted to run time) 0.85
Passed Customer Acceptance Test March 1955
Computer has operated for several days without any down time; however, the only actual figure is the 2,069 hours taken from the running time meter.

ADDITIONAL FEATURES AND REMARKS

Pre-addressed tapes
Single cycle operation where program is checked line for line.
Pre-determined automatic sequencing.
Shock-mounted for van installation; mobile.

INSTALLATIONS

U. S. Army Corps of Engineers
Topographic Engineering Department
Engineer Research and Development Laboratories
Fort Belvoir, Virginia

MONROBOT VI

Monroe General Purpose Computer Model VI

MANUFACTURER

Monroe Calculating Machine Company
Electronics Division

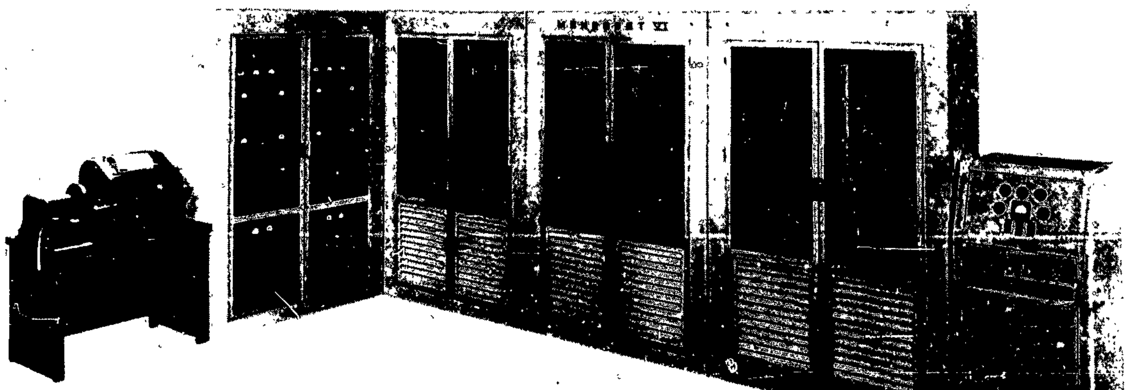


Photo by Monroe Calculating Machine Company, Electronics Division

APPLICATIONS

Scientific calculation.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	20
Decimal digits/instruction	10
Instructions per word	2
Instructions used	200
Arithmetic system	Fixed point
Instruction type	Four address
Number range	± xxxxx xxxxx . xxxxx xxxxx

Fixed point is centrally located

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add time	135,000
Mult time	600,000
Div time	600,000
Construction	Vacuum tubes and crystal diodes

Basic pulse repetition rate	10 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Automatic positioning of numerical results about the decimal point.

STORAGE

Medium	Words	Access Microsec
Magnetic Drum	200	16,670 max

4,000 digits of magnetic drum storage.

INPUT

Media	Speed
Keyboard	Manual
Punched Tape	10 char/sec
Punched Card	17 cards/sec

Punched tape is optional to 60 char/sec.
Standard teletype or Kleinschmidt units for tape processing.

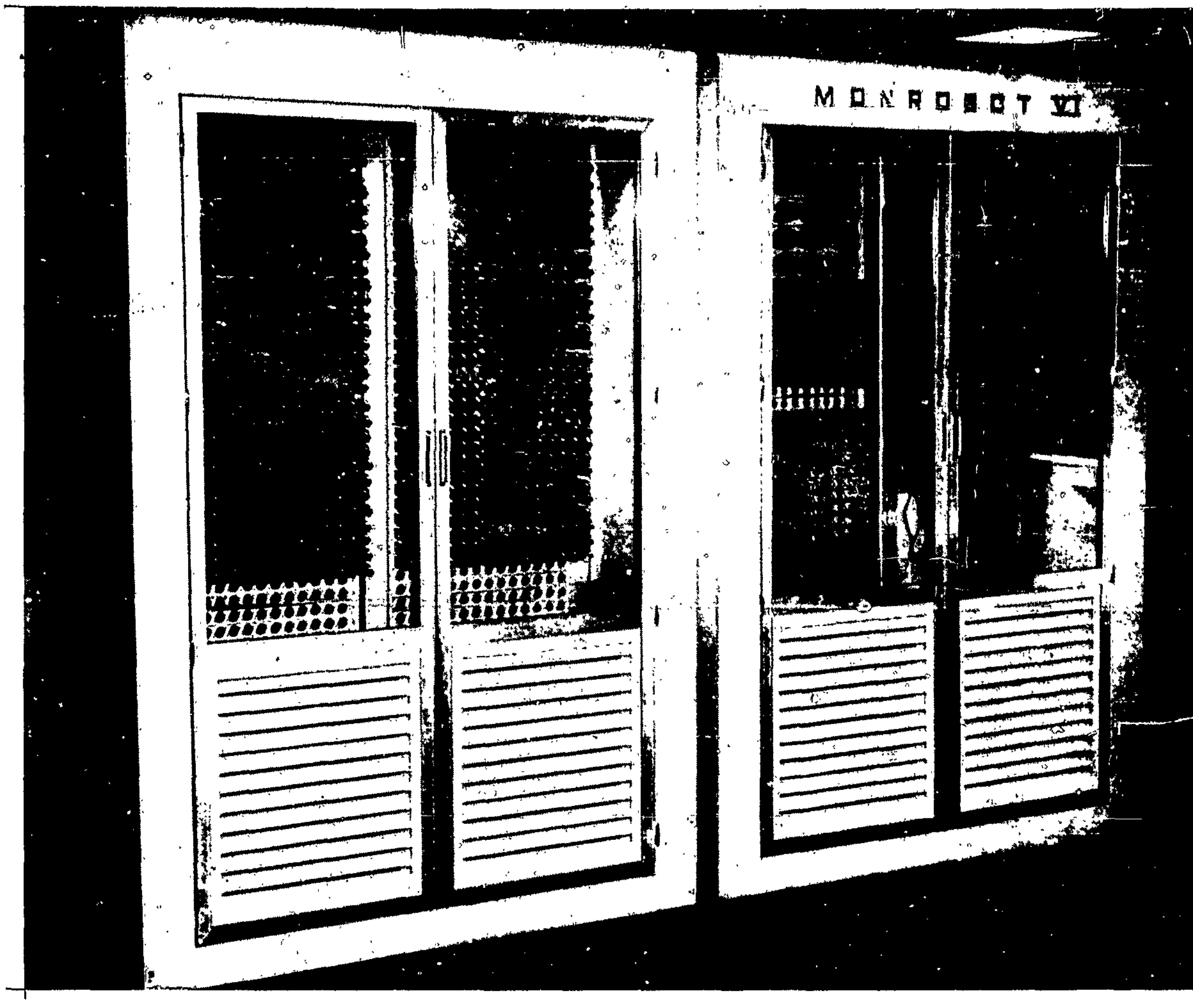


Photo by Monroe Calculating Machine Company, Electronics Division

OUTPUT

Media	Speed
Printed Copy	10 char/sec
Punched Tape	10 char/sec
Punched Card	17 char/sec

Standard teletype or Kleinschmidt units. 60 char/sec. Punched tape and punched card is optional.

CHECKING FEATURES

Parity checks
MAID (Monrobot Automatic Internal Diagnosis) and dual arithmetic and control units.

INSTALLATIONS

Several systems are at U. S. Air Force installations in Japan and Germany. These are under Monroe maintenance. The systems installed in the United States are not under Monroe maintenance.

Howard University

MONROBOT IX
Monroe Calculating Machine IX

MANUFACTURER
Monroe Calculating Machine Company

APPLICATIONS
System is used primarily for billing, and invoice writing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	62 bits

A plugboard program is used.

Instructions decoded	16
Arithmetic system	Fixed point
Instruction type	One address
Number range	0 to 10^{18}

System has 15 registers.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	12,000	3,000
Mult	13,500	per decimal digit of multiplier
Div	54,000	per decimal digit of quotient

Construction (Arithmetic unit only)

Vacuum-Tubes	64
Diodes	1,000
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Multiplication is accomplished by manual input of the multiplier digits. Therefore, actual speed is operator limited.

During division the quotient digits are printed, and the actual speed is therefore printer limited.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	15	18 decimal dig	12,500 avg

INPUT

Media	Speed
Electric Typewriter	10 char/sec
Plugboard	10 char/sec

Plugboard is used for constants and alphabetic characters.

Typewriter input is operator limited.

OUTPUT

Media	Speed
Electric Typewriter	10 char/sec
Numerical and alphabetic	
IBM 024 Card Punch	10 char/sec
Numerical	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
Primarily 5965	74
Diodes	
Primarily 1N636	1,000

POWER, SPACE, WEIGHT, AND SITE PREPARATION

KVA, computer	0.75
Volume, computer	32 cu ft
Area, computer	10.6 sq ft
Floor loading	40 lbs/sq ft
	150 lbs concen max
Weight, computer	450 lbs

Site preparation not necessary.

PRODUCTION RECORD

Number produced to date	70
Number in current operation	70
Time required for delivery	3 - 6 months

COST, PRICE AND RENTAL RATES

Computer with Typewriter	$9,650
List of additional equipment	
IBM (024) Intercoupler	$ 500
(IBM 024 - see IBM price list)	

90-day guarantee parts and labor. Service contract price is $500.

PERSONNEL REQUIREMENTS
One clerk is required for each 8-hour shift.

Ordinary typists are trained at customer location in one day.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Ambient temperature to 130°F
Voltage margins, ±25%
Pre-aged tubes used throughout.

ADDITIONAL FEATURES AND REMARKS

Computer has fewer tubes (74) than any other product known to us. Calculation is so fast operator experiences no delay. System handles fractions of any kind, feet, inches, gross, dozen, board feet, etc. Foreign currency such as pounds, shillings, pence, are handled. Step-rate utility billing is automatically performed.

System operates as a decimal machine externally. Input and output conversion are automatic. Decimal shift left and shift right instructions make this possible.

FUTURE PLANS

Punched tape output planned soon.

MONROBOT XI

Monroe Calculating Machine Mark XI

MANUFACTURER

Litton Industries
Monroe Calculating Machine Division

Photo by Monroe Calculating Machine Division

APPLICATIONS

The Monrobot Mark XI is a stored-program, general purpose electronic business computer capable of operation with a wide variety of input-output equipment.

Instruction word format

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Instruction						Address									

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	32 including sign
Binary digits/instruction	16
Instructions/word	2
Instructions decoded	27
Instructions used	27
Arithmetic system	Fixed point; programmed floating point
Instruction type	One address
Number range	0 to 2^{31} - 1 or 0 to $\pm$ 10^9 or 0 to $\pm$ 2, 147, 483, 647

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	9,000	3,000
Mult	34,000	28,000
Div	500,000	500,000

Division is programmed.

Construction (Arithmetic unit only)

Transistors	190
Diodes	1,675
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Average Access Microsec
Magnetic Drum	1,024	32,768	6,000

INPUT

Media	Speed
Punched Paper Tape	20 char/sec
Electric typewriter	10 char/sec
16-key numeric keyboard	10 char/sec
80-column card	16 col/sec
Teletypewriter	10 char/sec

The machine can accomodate any three of the above input devices simultaneously. Punched paper tape may be any code, 5 to 8 level. Quoted input and output speeds include conversion to and from binary as well as translation of any tape language to machine code. Higher speeds are possible using pure binary input and output.

OUTPUT

Media	Speed
Punched Paper Tape	20 char/sec
Electric Typewriter	10 char/sec
80-column Card	16 col/sec
Teletypewriter	10 char/sec

The machine can accomodate any three of the above output devices simultaneously. Punched paper tape may be any code, 5 to 8 level.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
5727	10 - 30 (10 tubes/output device)
Diodes	
Primarily 1N636	2,300
Transistors	
Primarily 2N412	383

CHECKING FEATURES

Parity check on input and output.
Parity may be omitted.
Action taken on parity failure depends upon program. With Teletype or other parity-less codes, parity is not used.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.850 Kw	0.940 KVA	0.9 pf
Volume, computer		48 cu ft	
Area, computer		15 sq ft	
Room size		10 ft x 10 ft	
Floor loading		30 lbs/sq ft	
		100 lbs concen max	
Weight, computer		375 lbs	

System requires 15 amp, 110 volt, AC, 60 cps line.

PRODUCTION RECORD

Number produced to date	7
Number in current operation	6
Time required for delivery	6 - 9 months

COST, PRICE AND RENTAL RATES

Cost of computer with operator desk, 1 typewriter, 1 tape reader, and 1 tape punch	$24,500
Additional Equipment	
16-key numeric keyboard	300
Tape Reader	1,250
Tape Punch	700
Typewriter	2,350
Buffer for third device	600

Above prices are approximate.
Monthly rental of computer with operator desk, 1 typewriter, 1 tape reader, and 1 tape punch, including service $700
Maintenance contracting is $1,200/year after 90-day service guarantee.

PERSONNEL REQUIREMENTS

Manufacturer makes a programmers' school available to users. One operator is required for each 8-hour shift. Virtually no operator training is required.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Conservative solid-state design assures long life and wide margins under all but the most extreme operating conditions. Pluggable printed circuit boards provide trouble-free operation as well as ease of maintenance. Monrobot XI operates with full $\pm 25\%$ voltage margins at 110°F ambient.

ADDITIONAL FEATURES AND REMARKS

The Monrobot Mark XI accepts alpha-numeric information in any code from up to three independent input devices and can output information to any combination of three independent devices.
System can simultaneously prepare independent output documents in any format, and can merge transaction and unit record input tapes in any format.

MONROBOT MU

Monroe Multiple-Unit General Purpose Computer

MANUFACTURER

Monroe Calculating Machine Company
Electronics Division

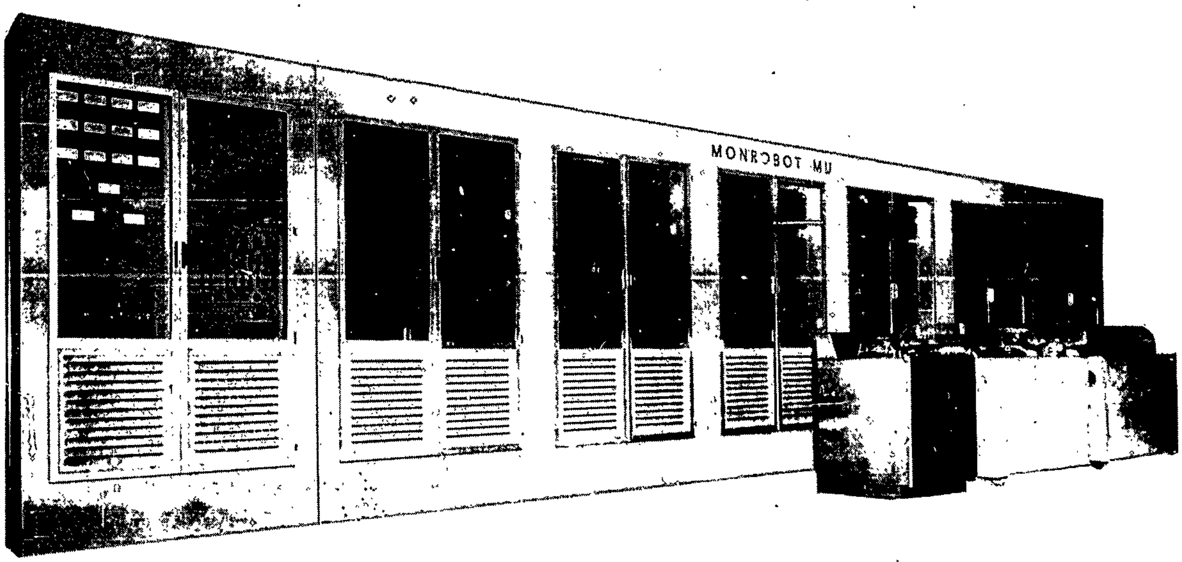


Photo by Monroe Calculating Machine Company, Electronics Division

APPLICATIONS

Item inventory and monetary accounting.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal and sexadecimal
Binary digits/word	96
Decimal digits/instruction	12
Instructions per word	2
Instructions decoded	36
Instructions used	36
Arithmetic system	Fixed point (arbitrarily located)
Instruction type	Three address (modified)
Number range	Variable

Words may be made up of either numeric or alphanumeric characters.

ARITHMETIC UNIT

	Includ Stor Access Microsec
Add time	8,000
Mult time	68,000
Div time	77,000
Construction	Vacuum tubes and crystal diodes
Basic pulse repetition rate	60 Kc/sec (rapid access) 104 Kc/sec (general storage)
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	Words	Access Microsec
Magnetic Drums	20,000/drum (general storage)	25,000 (avg)
Magnetic Drum	10 (rapid access)	1,600
Magnetic Tape (2)	12,000/unit	

The large capacity drums are for general storage and utilize saturable core reactors for track selection. The number of drums utilized is based upon application requirements.

INPUT

Media	Speed
Keyboard (Flexowriter)	10 char/sec
Keyboard (Model 28 Teletype 12 Units)	6 char/sec
Paper Tape (Ferranti)	200 char/sec
Magnetic Tape	400 char/sec

OUTPUT

Media	Speed
Paper Tape (Flexowriter)	10 char/sec
Printed Page (Flexowriter and Model 28 Teletype)	10 char/sec
Magnetic Tape	400 char/sec

CHECKING FEATURES

Parity checks
MAID (Monroe Automatic Internal Diagnosis)
System used for malfunction detection and location.

INSTALLATIONS

System was installed for the U. S. Air Force under Contract No. AF33(616)-2158.

NAREC

Naval Research Electronic Computer

MANUFACTURER

U. S. Naval Research Laboratory

Official United States Navy Photo

APPLICATIONS

General purpose scientific calculation and data processing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	48
Binary digits/instruction	24
Instructions/word	2
Instructions decoded	44
Arithmetic system	Fixed point
Instruction type	One address
Number range	-1 to +1

Instruction word format

Address				Order	
4	4	4	4	4	4

Half-word, six four-bit sexadecimal characters

Automatic built-in subroutines include punched tape input and output routines and variable length data transfer instructions (2 address).

Automatic coding includes floating point interpretive routines, containing standard mathematical subroutines as basic instructions.

Registers:

7 - 48 bit parallel registers in arithmetic section, including one adder and one inverter of which two are directly programmable.
1 - 48 bit parallel register in control section
1 - 16 bit parallel register in control section (program counter)
1 - 48 bit serial - parallel output buffer register
2 - 48 bit multiple use comparator registers
1 - 48 bit core memory information register
1 - 14 bit core memory address register
2 - 48 bit and 1 - 16 bit manual switch registers

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	22	6
Mult	300-600	same (approx range)=450
Div	575-725	same (approx range)=650

Division = 10 per digit (excluding access) for numerator = 0

Construction (Arithmetic unit only)

Type	Quantity
Vacuum tubes	
5687	600
5670	600
6AN5	100
Total	1,300
Transistors	0
Crystal diodes	16,000
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

Input-output is partially concurrent

STORAGE

Media	No. of Words	No. of Digits
Magnetic core	16,384	786,432

Memory cycle time is 8 microseconds

Magnetic drum	8,192	393,216

Maximum drum access is 33,333 microseconds

Magnetic tape

No. of units that can be connected	16 Units
No. of chars/linear inch	600 Chars/inch

Each line across the tape contains 2 characters of 8 bits each. Packing density = 300 lines/inch.

Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	.75 Inches
Tape speed	120 Inches/sec
Transfer rate	72 KC Chars/sec
Start time	3 Millisec
Stop time	2 Millisec
Physical properties of tape	
Width	1 Inch
Length of reel	2400-3600 Feet
Composition	Mylar

The above information on magnetic tape is preliminary only, as definite plans are now being formulated. The tape system should be installed in the NAREC by July 1961.

INPUT

Media	Speed
Magnetic Tape	120 in/sec
Paper Tape	25-100 in/sec

Dual speed photoelectric reader at 250 and 1000 char/sec using mylar-aluminum foil and paper tape.

OUTPUT

Media	Speed
Paper Tape	60-110 char/sec

High and medium speed paper tape punches

Magnetic Tape	120 in/sec

Line Printer

Line Printer will be installed by July 1961.
Speed of 600-1200 lines/minute is anticipated.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
5687	600
5670	600
6AN5	100
	1,300

Does not include electrostatic memory which is being replaced by magnetic core memroy.

Diodes		
1N89	16,000	
SG22	1,800	
DR211	7,000	
1N690	4,000	
650C5	250	Zener Diodes
651C0	350	(Texas Instruments)
651C7	600	
	30,000	

1N89 used in arithmetic section. All others used in magnetic core memory.

Transistors	
2N1478	1,000
2N600	500
2N1122	3,000
2N1123	300
	4,800

All Philco transistors are used in Telemeter Magnetics Core Memory.

Magnetic Cores		
.050 inch x .030 inch	900,000	
Telemeter Magnetics 501-10		
Capacitors	10,000	(core memory)
	3,000	(arith. section)
	13,000	
Resistors	20,000	(core memory)
	7,000	(arith. section)
	27,000	

CHECKING FEATURES

Automatic comparison bit by bit of all transfers between registers in arithmetic and control sections by means of 2 - 48 bit comparator registers.

Magnetic tape system will have conventional parity checks and sense instructions.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	25 Kw
Power, air conditioner	15 Kw
Volume, computer	1,000 cu ft
Area, computer	125 sq ft
Room size, computer	30 ft x 80 ft
Capacity, air conditioner	25 Tons
Weight, computer	5,000-10,000 lbs

Site preparation included concrete trenches in floor for power wiring and coaxial cables. Power includes both M-G sets and electronic power supplies.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Total system cost approximately $1,500,000.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors	2	2
Programmers	10	20
Clerks	2	2
Engineers	1	2
Technicians	3	5

Operation tends toward semi-open shop. Includes programmers in central facility and in other groups of the Laboratory. Programmers above includes analysts and coders. The above does not provide for magnetic tape or printer operation. Technicians above includes operators.

Training made available by manufacturer includes in-service programming courses by Research Computation Center for rest of the NRL.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Approximately 1 hour per shift is required for scheduled maintenance.

Operating efficiency (ratio of good time to scheduled operating time) has averaged 85% over the past four years (1956-1960) of full time operation. This is expected to improve considerably in the future due to the current replacement of electrostatic storage by magnetic core storage.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a special console, which displays the contents of core memory address abd information registers and permits direct manual read and write to core memory locations.

Unique system advantages include computation monitored from control console without loss of time to stop computer at desired location or instruction in many different ways in order to facilitate program and machine checking. Instruction code and layout is very simple to use and remember, yet is extremely powerful and flexible.

Flexowriters are used in parallel to print results of several problems simultaneously. A centralized operating area consists of photoelectric tape readers, high speed punch, Flexowriter and core memory console adjacent to main control console.

FUTURE PLANS

Magnetic core memory installed in October 1960. Magnetic tape system and line printer will be installed by July 1961.

INSTALLATIONS

U. S. Naval Research Laboratory
Washington 25, D. C.

NATIONAL 102A

National Cash Register Company
Model CRC 102A
Built by former Computer Research Company

MANUFACTURER

National Cash Register Company

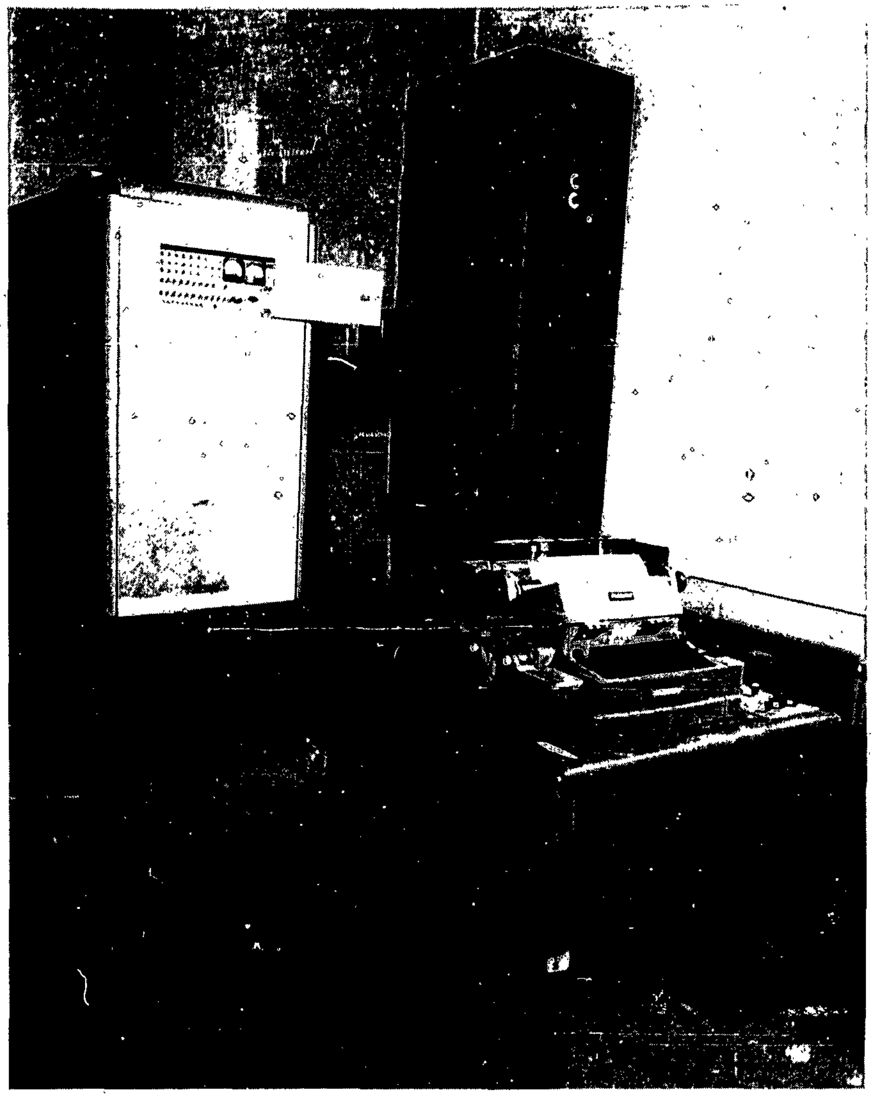


Photo by U. S. Army Chemical Center

APPLICATIONS

Manufacturer
General purpose scientific applications
Chemical Warfare Laboratories, U.S. Army Chemical Center
Scientific
U.S. Naval Ordnance Test Station (China Lake)
Data reduction general purpose
U.S. Naval Postgraduate School
Located at Monterey, California, the system is used for scientific applications, including student and faculty research in practically all phases of the physical sciences, for data processing, including weather prediction, and for simulation, including electronics systems and games (business, industrial and military).
Holloman Air Development Center (ARDC)
Trajectory calculations, heat transfer problems, solution of various kinds of linear simultaneous equations and other algebraic equations.

Photo by U.S. Naval Post Graduate School
Official Photograph U.S. Navy

U.S. Air Force School of Aviation Medicine
Located at Brooks Air Force Base, Texas, the system is used for matrix algebra (Covariance, symmetric and non-symmetric mult. and inversion programs, corr), factor analysis (Factoring the correlation matrix and rotating the factor vector), for general analysis statistics (Mean, variance, and st. deviations; and analysis of variance), time series analysis (Circular serial correlation, autocorrelation, periodograms), and for Monte Carlo methods, generating pseudo random fractions (runs, means, frequency).

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer	
Internal number system	Binary
Binary digits/word	42 (One for timing)
Binary digits/instruction	41
Instructions per word	1
Instructions decoded	27
Instructions used	27
Arithmetic system	Fixed point
Instruction type	Three address
Number range	$-(1-2^{-36})$ to $(1-2^{-36})$

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	19,900	7,400
Mult	37,500	25,000
Div	38,500	25,800

Construction	300 Vacuum tubes 4,000 Diodes
Rapid access word registers	8
Basic pulse repetition rate	100 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

The speed can be increased by a factor of 8 when a buffer is used.

STORAGE

Media	Words	Microsec Access
Magnetic Drum	1,024	12,500 (avg)
Magnetic Tape	112,800/reel	6,000

Up to 7 tape units may be used with one computer.
Magnetic drum rotates at 40 rev/sec.

INPUT

Media	Speed
Manufacturer	
Flexowriter	Typing Speed
Punched Paper Tape	10 char/sec
Magnetic Tape	1.6 char/millisec
U.S. Army Chemical Center	
Flexowriter	Typing Speed
Punched Paper Tape	10 char/sec
Magnetic Tape	64 words/sec
U.S. Naval Ordnance Test Station	
Punched Paper Tape	10 char/sec
IBM Cards (523 modified)	50 cards/min
U.S. Naval Post Graduate School	
Paper Tape	10 char/sec
Cards	60 cards/min
	240 words/min
Magnetic Tape	60 words/sec
School of Aviation Medicine	
Flexowriter	Typing Speed
Punched Paper Tape	10 char/sec
IBM Cards	50 or 100 cards/min
Magnetic Tape	1.6 char/millisec

OUTPUT

Media	Speed
Manufacturer	
Magnetic Tape	600 char/sec
Flexowriter	10 char/sec
Punched Paper Tape	10 char/sec
U.S. Army Chemical Center	
Magnetic Tape	64 words/sec
Flexowriter	10 char/sec
Punched Paper Tape	10 char/sec
U.S. Naval Ordnance Test Station	
Flexowriter	10 char/sec
Punched Paper Tape	10 char/sec
IBM Cards (523 modified)	50 cards/min

U.S. Naval Post Graduate School

A digital point is used, which operates independently of computer. No conversion is necessary for plotting. The plotter is manufactured by the California Computer Products Corporation.

Paper Tape	10 char/sec
Cards	60 cards/min
Magnetic Tape	60 words/sec
School of Aviation Medicine	
Flexowriter	10 char/sec
Paper Tape	10 char/sec
Cards	50 or 100 cards/min
Magnetic Tape	600 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	400
Tube types	12
Crystal diodes	8,000

U.S. Army Chemical Center

Tube types used include 12AT7, 12BH7, 6BQ7, 5687, 5963, 6080, 5881, and 6AN5. System utilizes 265 tubes and 6,000 diodes and consists of operators console, computer proper, and magnetic tape unit.

CHECKING FEATURES

Duplicate recording on magnetic tape
"Overflow" alarm"
"No command" alarm

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	7.7 Kw
Weight, computer	2,700 lbs

U.S. Army Chemical Center

Computing system occupies 135 cu ft, air conditioner 48 cu ft. The computing system weighs 3,400 lbs, air conditioner weighs 12,000 lbs. The capacity of the air conditioner is 6 Tons.

U.S. Naval Ordnance Station

System operates a 230v ±5% line, liberates 35,000 BTU/hour. Computer occupies 72 cu ft and 12 sq ft (Dimensions are 30 by 59 by 73 inches).

U.S. Naval Post Graduate School

Power, computer 5.5 Kw	7.7 KVA	0.71 pf
Volume, computer	108 cu ft	
Volume, air conditioner	360 cu ft	
Area, computer	18 sq ft	
Area, air conditioner	36 sq ft	
Room size Approx	2,800 sq ft	
Floor loading	200 lbs/sq ft	
	700 lbs concen max	
Capacity, air conditioner	25 Tons	
Weight, computer Approx	2,000 lbs, total	

Lobby section of one of the school buildings was partitioned. False flooring, air conditioning and power were installed in the laboratory section which houses two computers (CDC 1604 and NCR-CRC-102A) and their associated peripheral equipment.

School of Aviation Medicine

Power, computer 5.5 Kw	7.7 KVA	0.7 pf
Volume, computer	72 cu ft	
Area, computer	12 sq ft	
Room size	20 ft x 12 ft	
Floor loading	225 lbs/sq ft	
	60 lbs concen max	
Capacity, air conditioner	5 Tons	
Weight, computer	2,700 lbs	
Air conditioner	central unit	

System required primary power source due to sensitivity to power fluctuations.

PRODUCTION RECORD

Manufacturer

Produced	16
Operating	16

COST, PRICE AND RENTAL RATES

U.S. Army Chemical Center

Approximate cost of basic system	$70,000
Approximate cost of additional equipment	$25,000
Rental rates for basic system	$ 2,400/month

U.S. Naval Post Graduate School

Computer, 2 tape drives, console, Flexowriter (paper tape reader and punch), point plotter cost approximately $100,000.

Rental rates for additional equipment, to include the 2 IBM 523, IBM 402, IBM 082, and IBM 026 is $600 per month.

Approximately $9,500 per year is paid to the National Cash Register Company for maintenance service.

School of Aviation Medicine

The 102A Computer cost approximately $80,000.
The 126A Magnetic Tape Unit cost approximately $15,000.
Two IBM Summary Punches (No. 523) rent at approximately $2,100 per year.
Air Force personnel perform servicing of the system.

PERSONNEL REQUIREMENTS

U.S. Army Chemical Center

One 8-hour shift requires 1 engineer and 1 technician-operator.

U.S. Naval Ordnance Test Station

One 8-hour shift requires 1 engineer, 2 programmers, and 1 "open shop" personnel.

U.S. Naval Post Graduate School

The computers are available for student and faculty research 24 hours per day. Those students and faculty who have been checked-out on the operation of the computers and peripheral equipment are permitted out-of-hours production runs on the computers. Potentially the school has approximately 1,000 programmer-operators under this system. At the present time the CDC 1604 operates approximately 14 hours per day and the NCR 102A 20 hours per day, 7 days per week.

Course work is given in the Engineering School on programming, operation and applications.

Seminars are given at the school.

School of Aviation Medicine

	One 8-Hour Shift
Analysts	1
Programmers	1
Operators	1
Engineers	1

Operation tends toward open shop.

On-the-job training (OJT) is given.

Gulf Research and Development Company

Central computing section consists of 1 engineer, 1 operator, 1 secretary-librarian, and 5 administrative, numerical analysis and programming personnel, for slightly more than an 8-hour shift.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

U.S. Army Chemical Center

Good time	3,380 hours
Attempted to run time	5,200 hours
Operating ratio (Good/Attempted to run time)	0.65

Figures based on a 2.5 year period

Passed Acceptance Test Jun 54

U.S. Naval Ordnance Test Station

Average error-free running period	80 hours
Operating ratio (Good/Attempted to run time)	0.90

Figures based on period 1 Jan 55 to 10 Nov 56

Passed Acceptance Test 1 Jun 54

U.S. Naval Post Graduate School

Passed Acceptance Test Summer of 1953

Time is not available for rent to outside organizations.

Since August 1958, the NCR 102A has averaged in excess of 100 hours per week operating time and has averaged less than 2 hours per week of forced downtime due to equipment failure. Each working day there is a two hour preventive maintenance period.

School of Aviation Medicine

Good time	36 Hours/Week (Average)
Attempted to run time	40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.90

Above figures based on period from Fall 54 to 1 Jul 59

Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Holloman Air Development Center (ARDC)

Two systems have been in use since 1953. Additional input/output equipment includes 3 magnetic tape units (NCR 128), and 1 summary card punch (IBM 523).

U.S. Army Chemical Center

The three-address system permits ease of programming and coding not present in one or two address systems.

Additional features include: Bit positions available in the structure of commands for flagging internal addresses for automatic coding and repositioning of programmed routines. Logic designed such that automatic links to and from subroutines are accomplished easily. Large storage capacity and three-address commands. Tape unit searches independently of the computer, once the block address is set up. High speed paper tape input reader. A visual display of the control register while computing and when idle. All logical diodes accessible, diodes are of clip-in type, plug-in units replaceable for repair.

U.S. Naval Post Graduate School

The system is used primarily for the education of the officers in the Engineering School. Other computing time after normal training hours is used by government agencies in the Monterey area on a non-interference basis.

The plotter output is considered to be a very valuable part of the system permitting rapid observation of results. The binary information is plotted directly on graph paper, thus avoiding the problem of converting to decimal. The plotter has three plotting symbols.

Gulf Research and Development Company

Auxiliary equipment consists of:

2 NCR 126 Magnetic Tape Units.

Two Flexowriters, each capable of serving as the input-output device for the computer. A third Flexowriter, not modified, for input-output functions.

One IBM 514 Reproducing Punch, modified for use as an output device.

A photoelectric paper tape system based upon a Ferranti reader has been constructed.

Two more one-word recirculating registers have been made addressable, making them correspond roughly to the accumulator and Q-register of a typical one-address computer.

INSTALLATIONS

Holloman Air Development Center (ARDC)
Holloman Air Force Base, New Mexico

School of Aviation Medicine
Randolph Air Force Base, Texas

Chemical Warfare Laboratories
U. S. Army Chemical Center, Maryland

U. S. Naval Ordnance Test Station
China Lake, California

U. S. Naval Post Graduate School
Monterey, California

A. V. Roe, Ltd.
Malton, Ontario, Canada

Great Lakes Pipe Line Company
Kansas City, Missouri

Gulf Research and Development
P. O. Drawer 2038
Pittsburgh 30, Pennsylvania

Polytechnic Institute of Milan
Milan, Italy

Royal Canadian Air Force
Edmunton, Alberta, Canada

NATIONAL 102D

NCR CRC Model 102 D

MANUFACTURER

The National Cash Register Company

Photo by The National Cash Register Company

APPLICATIONS

Manufacturer

General purpose scientific application

Pitman-Dunn Laboratories

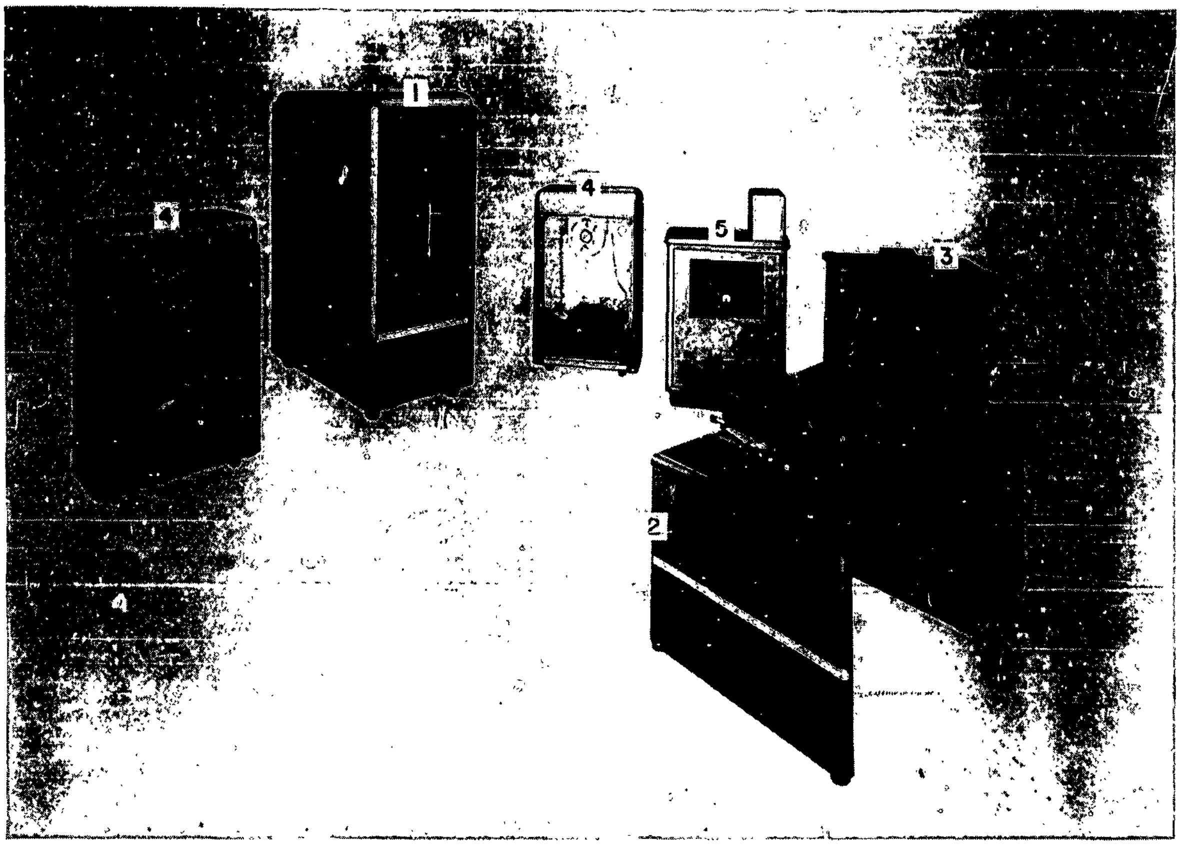
The system is used for general scientific computing, to include trajectories, other differential equations, interior and exterior ballistics, fire control problems, curvefitting, solution of algebraic equations, simulations, etc.

The National Cash Register Company

Located at the Research and Development Division, The National Cash Register Company, Dayton, Ohio, the system is used to support the physical and chemical investigations of the Research and Development Division by processing experimental data originating in the research and engineering laboratories. Work in such fields as logical design, wiring diagrams for logical systems, cam design, and statistical analysis of data are typical of the applications made.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	9 plus 6 bin dig/word
Binary digits/instruction	42
Instructions per word	1
Instructions decoded	27
Arithmetic system	Fixed point
Instruction type	Three address
Number range	$-(1-10^{-9})$ to $+(1-10^{-9})$
or	$-(1-2^{-36})$ to $+(1-2^{-36})$



1 Computer, 2 Control Consol, 3 High Speed Paper Tape Reader, 4 Magnetic Tape Units, 5 High Speed Paper Tape Punch

Photo by The National Cash Register Company

Magnetic tape searches approx. 90"/sec., reads/writes 15"/sec. (approx. 59 words/sec)

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	7,800	4,000
Mult	21,100-49,100	15,000
Div	21,100-53,200	15,500

Construction	Vacuum tubes
Rapid access word registers	8
Basic pulse repetition rate	100 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	Words	Digits	Access Microsec
Magnetic Drum	1,024	43,008	12,500 avg
Magnetic Tape	102,000/reel	918,000/reel	

Pitman-Dunn Laboratories

Media	No. of Words	No. of Digits/Word	Min Access Microsec
Magnetic Drum	1,032	14 octal or 9 decimal	390
Magnetic Tape	110,000	Same	

INPUT

Manufacturer

Media	Speed
Paper Tape (Flexowriter)	10 char/sec
Paper Tape (Photoelectric)	200 char/sec
Magnwtic Tape	600 char/sec
Keyboard (Flexowriter)	Manual
Punched Cards	4,000 char/min

Pitman-Dunn Laboratories

Media	Speed
Keyboard or Paper Tape	6 char/sec
Hi-Speed Tape Reader	160 char/sec
Magnetic Tape	59 words/sec
IBM Card Reader	100 cards/min

Six channel Flexowriter is used. Cards contain 4 words each.

Photo by The National Cash Register Company

OUTPUT

Manufacturer

Media	Speed
Paper Tape (Flexowriter)	10 char/sec
High Speed Punch	60 char/sec
Magnetic Tape	600 char/sec
Punched Cards	4,000 char/min
Pitman-Dunn Laboratories	
Typed Page	6 char/sec
Paper Tape (High Speed)	60 char/sec
Card (IBM)	100 cards/min

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Tubes	425
Tube types	15
Crystal diodes	8,500

CHECKING FEATURES

Manufacturer

Duplicate recording on magnetic tape
"Overflow" alarm
"No command" alarm

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer		7.7 Kw	
Area, computer		250 sq ft	
Weight, computer		2,700 lbs	
Pitman-Dunn Laboratories			
Power, computer	8.2 Kw	11.6 KVA	0.71 pf
Power, air conditioner		61.5 KVA	
Volume, computer		154.5 cu ft	
Volume, air conditioner		2,318 cu ft	
Area, computer		49 sq ft	
Area, air conditioner		206.5 sq ft	
Room size, computer		19 ft x 39 ft	
Room size, air conditioner		11 ft x 25 ft	
Floor loading		84 lbs/sq ft	
		425 lbs concen max	
Capacity, air conditioner		60 Tons 720,000 BTU	
Weight, computer		4,110 lbs	
Weight, air conditioner		6,600 lbs	
Weight, cooling tower		2,500 lbs	

Power includes Input-Output systems.

One 5 KVA and one 10 KVA Sol A transformers are used for voltage regulation. Power outlets for main computer and auxiliary equipment were installed. Air

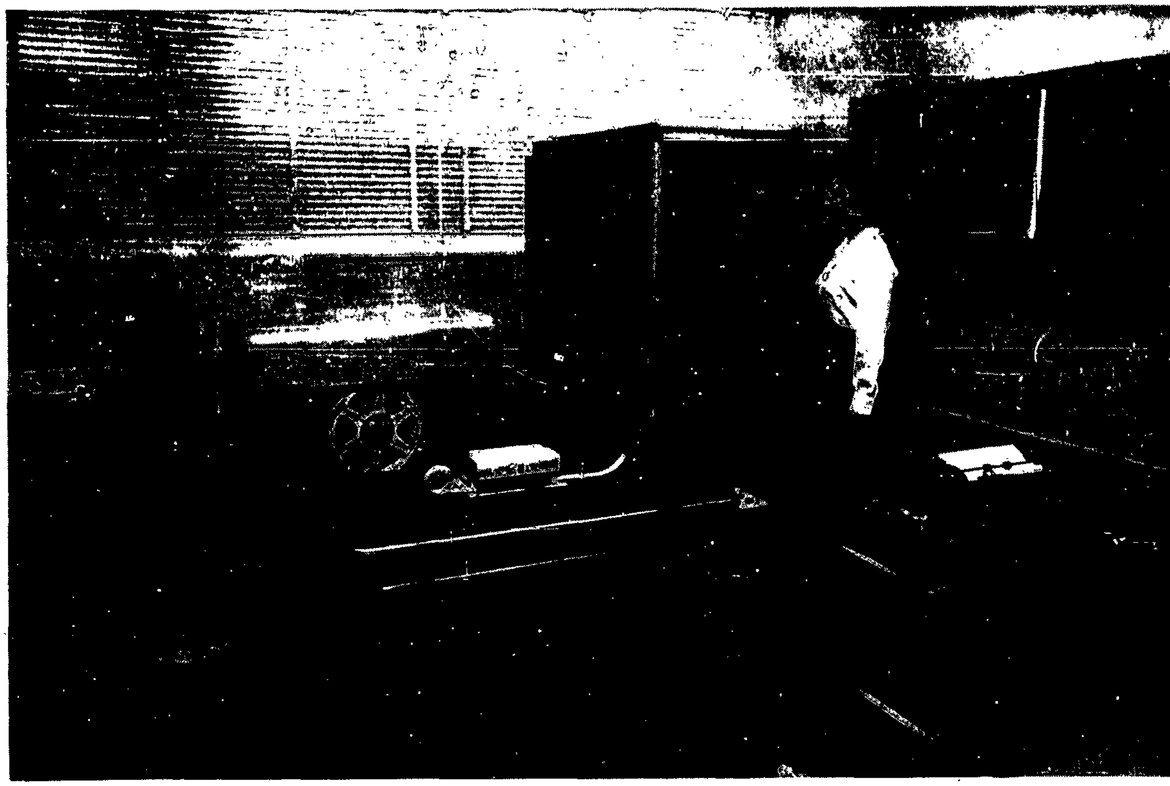


Photo by the Georgia Institute of Technology

conditioner services personnel and an analog computer also.

COST, PRICE AND RENTAL RATES

Manufacturer

Approximate cost of basic system	$65,000
Approximate cost of additional equipment	
Magnetic Tape Unit Model 126	$16,000
High Speed Reader Model 160	9,500
High Speed Punch Model 170	5,000
Flexowriter	2,900
Rental rates for basic system	$2,400/month
Rental rates for additional equipment	
High Speed Reader Model 160	275/month
High Speed Punch Model 170	220/month
Flexowriter	150/month

Pitman-Dunn Laboratories

Computer w/console, Flexowriter mag. tape unit, hi-speed reader, hi speed punch, including transportation and installation cost $83,370.

Off-line Flexowriter cost $2,900 additional.

IBM equipment includes 2-523's, 2-026's, 1-08_, 1-085, 1-514, and 1-402, which rents at $12,624/year.

Maintenance for purchased equipment is $12,624/year.

PERSONNEL REQUIREMENTS

Pitman-Dunn Laboratories

	One 8-Hour Shift
Analysts	1
Programmers	2
Technicians	1

Operation tends toward closed shop.

Methods of training includes basic programming course and use of the programming manuals. Programmers code and run their own problems.

The National Cash Register Company

	One 8-Hour Shift
Supervisors	1
Coders, Programmers & Analysts	3
Technicians	1

Operation tends toward open shop. Individuals may have programs entirely written by department personnel, written by themselves with assistance from department, or written entirely by thwmselves. Individuals desiring running time for a problem most commonly supply their own operator.

Methods of training used includes on-the-job training of department personnel, informal training of other research personnel.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Pitman-Dunn Laboratories

Average error-free running period	4 Hours
Good time	26 Hours/Week (Average)
Attempted to run time	39 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.67

Above figures based on period 1 Apr 59 to 30 Apr 60

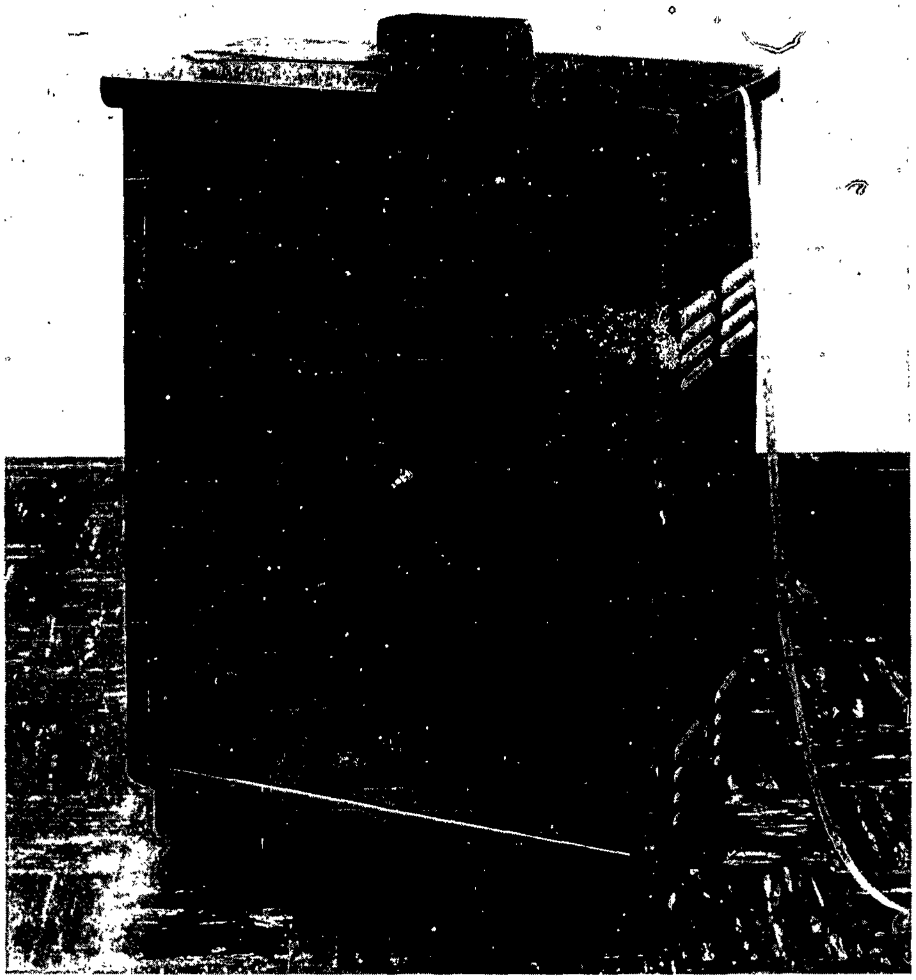
Passed Customer Acceptance Test Jan 58

Time is not available for rent to outside organizations.

4 hours of preventive maintenance is performed.

The National Cash Register Company

Good time	28.5 Hours/Week (Average)
Attempted to run time	32 Hours/Week (Average)



High Speed Reader

Photo by The National Cash Register Company

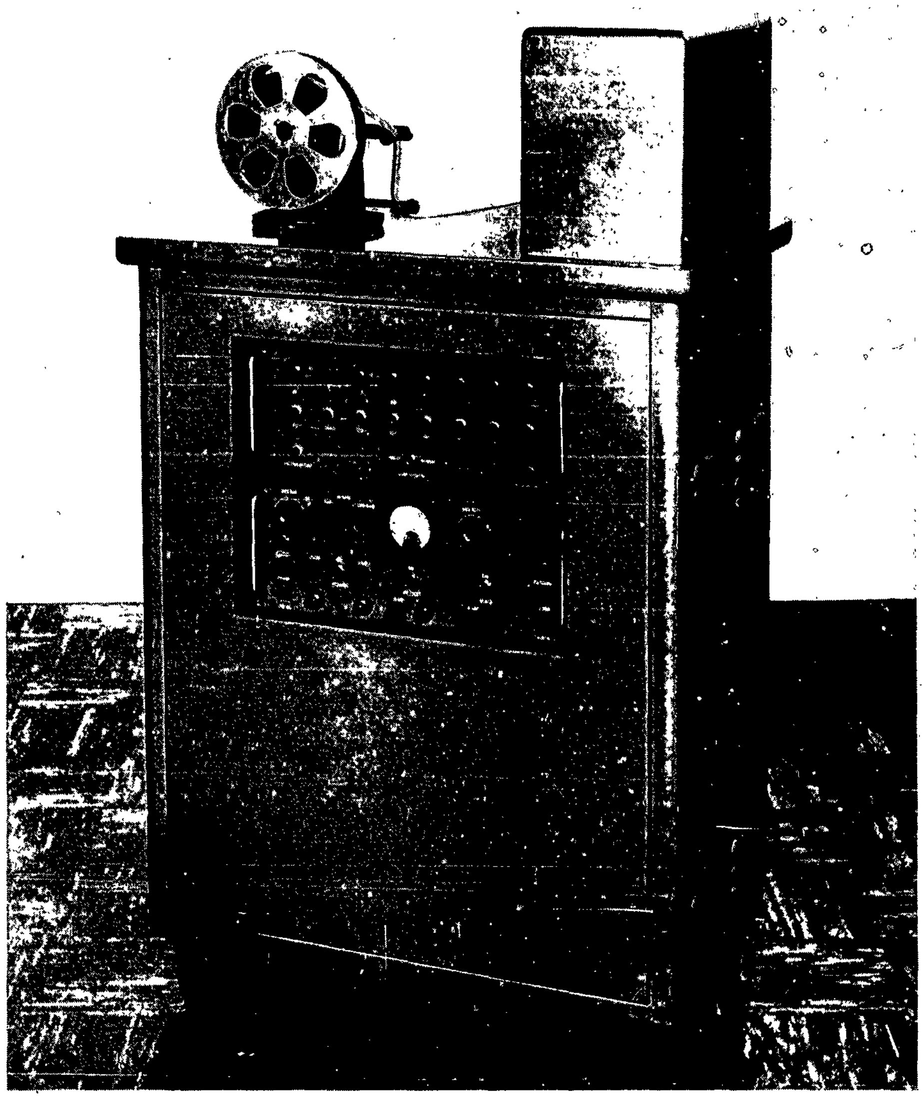
Operating ratio (Good/Attempted to run time) 0.89
Above figures based on period from Jul 59 to Aug 60
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Pitman-Dunn Laboratories
Outstanding features include 3 address system, which is easy to use.

FUTURE PLANS

Pitman-Dunn Laboratories
System expected to be replaced by second quarter Fiscal Year 61 with system comparable with DATATRON 205, IBM 650, or UNIVAC Solid State.



High Speed Punch

Photo by The National Cash Register Company

INSTALLATIONS

Dow Chemical Company
Midland, Michigan

Rice Electronic Computer Center
Georgia Institute of Technology
Atlanta, Georgia

Research and Development Division
The National Cash Register Company
Dayton, Ohio

The National Cash Register Company
Hawthorne, California

Pitman-Dunn Laboratories
Frankford Arsenal
Philadelphia, Pennsylvania

NATIONAL 107

National Cash Register Corporation Model 107

MANUFACTURER

National Cash Register Corporation

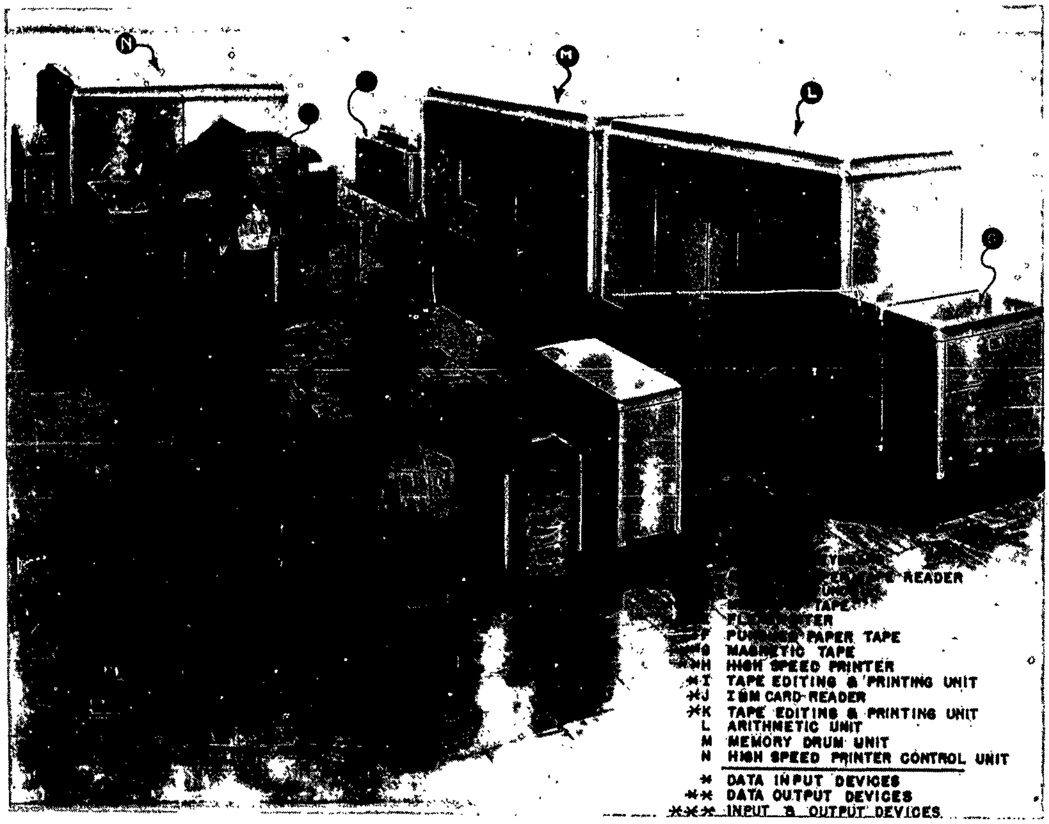


Photo by U. S. Naval Academy

APPLICATIONS

Located in Ward Hall, U. S. Naval Academy, the system is used to demonstrate to Naval Academy faculty and midshipmen, automatic calculations using a large data processing/scientific type digital computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	11
Decimal digits/instruction	2
Instructions/word	1 + sign
Instructions decoded	22
Arithmetic system	Fixed point
Instruction type	Three address
Number range	$-(1 - 10^{-9}) \leq x \leq 1-$

The excess-three system of binary coded decimal notation is used.

ARITHMETIC UNIT

	Incl. Stor Access
Operation Time	Microsec
Add	15,000
Mult	40,000
Div	40,000

Construction (Arithmetic unit only)

Vacuum-tubes	625
Diodes	2,040
Arithmetic mode	Parallel

Parallel by bit, serial by digit.

Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Drum	11,000	121,000	3,000

Magnetic Tape

No. of units that can be connected	99 Units
No. of char/linear inch of tape	134 Char/inch
Channels or tracks on the tape	10 Tracks/tape
Blank tape separating each record	10 Inches
Tape speed	15 Inches/sec
Transfer rate	2,010 Char/sec
Start time	3 Millisec
Stop time	3 Millisec
Average time for experienced operator to change reel of tape	120 Seconds
Physical properties of tape	
Width	1 Inch
Length of reel	3,600 Feet
Composition	Mylar or Acetate

All tape must initially be pre-clocked off-line.

INPUT

Media	Speed
Card (IBM)	100 cards/min
Magnetic Tape	15 in/sec, 121 char/in
Paper Tape	120 char/min
Keyboard (Flexowriter)	Manual

OUTPUT

Media	Speed
High Speed Printer	600 lines/min, 120 char/line
Magnetic Tape	15 in/sec, 121 char/in
Cards (IBM)	100 cards/min
Typewriter (Flexo)	120 char/min
Paper Tape	120 char/min

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	800
Diodes	2,500

CHECKING FEATURES

Unwanted Digit
Command Check
Overflow
Conditional Halt

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	208 Volts	3 phase	60 cps
Power, air cond	208 Volts	3 phase	60 cps
Volume, computer	65,774 cu ft		
Volume, air conditioner	126 cu ft		
Area, computer	1,711 sq ft		
Area, air conditioner	18 sq ft		
Room size, computer	1,800 sq ft		
Capacity, air conditioner	15 Tons		
Weight, computer	12,000 lbs		
Weight, air conditioner	1,000 lbs		

Building was modified for computer installation.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

Produced for U. S. Navy Bureau of Aeronautics to their design specifications.

COST, PRICE AND RENTAL RATES

Basic System

Original cost, $1,000,000 to Navy BUAER (original owner). System consists of control console, arithmetic section, high speed printer, 8 magnetic tape units, and memory section.

Additional Equipment

For the IBM 514, IBM 523, IBM 024, the total rent is $108.00 per month (including educational discount 60%).

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Supervisors	1
Operators	2
Technicians	3

Operation tends toward open shop.

Methods of training used is classroom and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Operating experience over four year period approximately 98% of scheduled production at previous location in Washington, D. C. (Navy Bureau of Weapons).

ADDITIONAL FEATURES AND REMARKS

Outstanding features are block search on tape handles at rate of 600 words/sec, off-line preparation and verification of tape input, and large memory with maximum of 10 word access.

FUTURE PLANS

Addition of X-Y plotter and weapons system simulation for educational purposes.

INSTALLATIONS

U. S. Naval Academy
Weapons Department
Annapolis, Maryland

NATIONAL 304

National Cash Register 304

MANUFACTURER

National Cash Register Company

Photo by National Cash Register Company

APPLICATIONS

Manufacturer

The system is a general-purpose data processing system for industrial, governmental and educational organizations. It is intended for commercial and scientific applications. All commonly-used inputs and outputs, a magnetic tape system with unique characteristics, and flexibility in system organization result in a powerful system with versatility of application.

U.S. Marine Corps, Camp Lejeune

Located on the base, the system is used for USMC personnel accounting.

U.S. Marine Corps, Camp Pendleton

Located at the U. S. Marine Corps, Camp Pendleton the system will be used to maintain current magnetic tape records on approximately one half the Active and Organized Reserve Establishments of the Marine Corps. Weekly, Changed Record Tapes will be forwarded to Headquarters, Marine Corps to overlay Headquarters' Tape Records. Headquarters will prepare personnel reports for itself, Navy Department, and Department of Defense from its Magnetic Tape Files. Meanwhile, this installation will prepare "Field Personnel Reports" for 14 major field commands in the western complex. (DPI, MCB, Camp Lejeune, North Carolina performs the same function for the eastern complex, i.e., the other half of the Marine Corps.) Implementation of the system is scheduled for August 1960.

U.S. Marine Corps, Headquarters

Located at the Arlington Navy Annex, the system is utilized for military personnel accounting.

The three U.S. Marine Corps NCR 304 Data Processing Systems are utilized in an integrated Military Personnel Accounting and Reporting System. The systems located in California and North Carolina servicing the two major Marine Corps bases and reporting to the system located in Washington D. C.

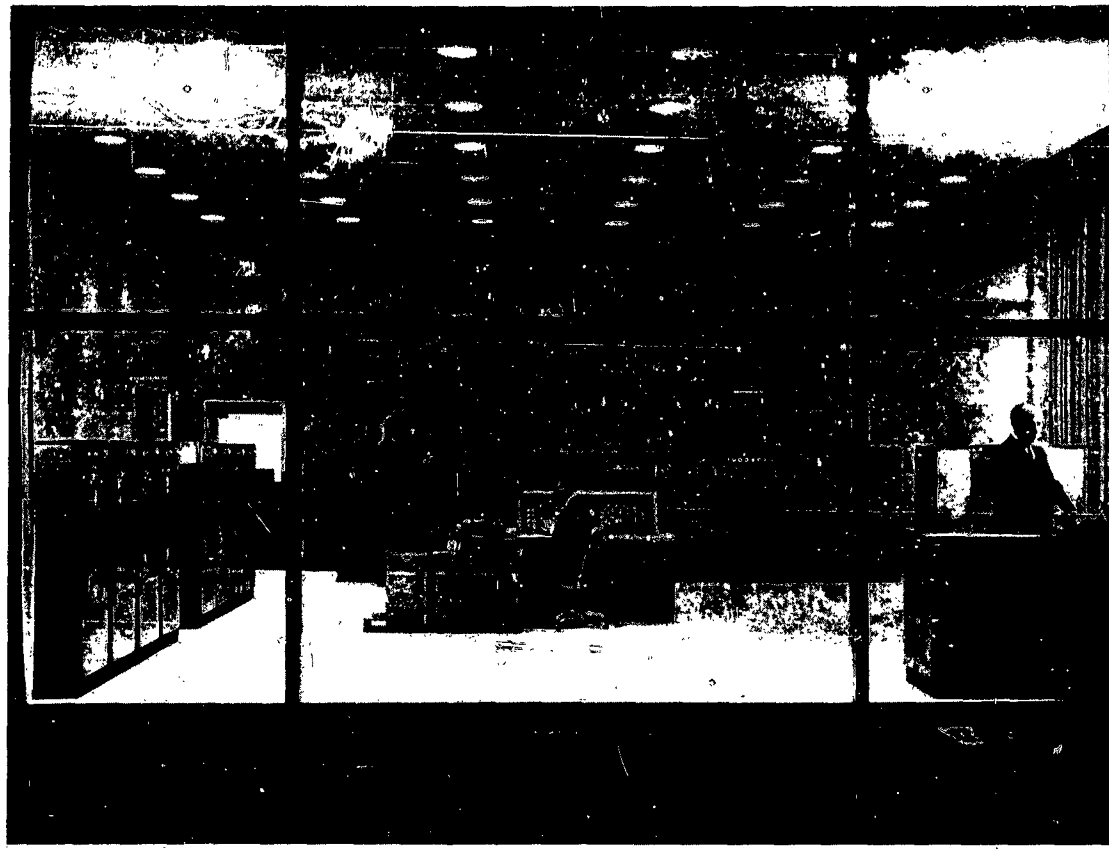


Photo by National Cash Register Company

American United Life Insurance Company
Located at 30 W. Fall Creek Parkway, N. Dr. - Indianapolis, Indiana, the system is used to maintain Master Tape Files of policyholders, agents, payroll, general ledger, mortgages, securities, update daily any transactions that affect any master record or file, compute commissions, journalize daily - Maintain accounting controls, balance books of account. Perform premium billing and policy conservation advices, control disbursements, bank reconciliations, and compute dividends, cash values, premiums, reserves, interest, etc.

S. C. Johnson & Son, Inc.
Located at 1525 Howe Street, Racine, Wisconsin, the system is used for order processing, inventory control, accounts receivable, credit and collection, freight allocation, sales statistics, and allied financial reports.

National Cash Register Company, Hawthorne
Located at the National Cash Register's Electronics Division, Hawthorne, California, the system is used for electronic data processing service to business, industry and government. Complete facilities for handling customer created input - punched paper tape and cards. It is used for program check out for 304 customers. The system is used internally by the National Cash Register Company for programming research, automated logical design, and data processing. Back up support for other 304 systems is additional use.

Bureau of Yards and Docks
Located at the Bureau of Yards and Docks, Washington D. C., the system is used for the management of the Military Construction Program, the inventory of Automotive Equipment, the inventory of Construction Equipment, and for engineering applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Alphanum char/word	10
Alphanum char/word	5 - 60
Words/instruction	1/2 - 6
Instructions decoded	83 one address
	37 three address w/variations
Arithmetic system	Floating point

MICROFLOW provides exponents in range of -50 to + 49 and automatic normalizing of result

	Fixed point

Automatic alignment takes place

Instruction type	One address (MICROFLOW) (Scientific-type)
	Three address (Multi-address) (Business-type)
Number range	$-(1-10^{-10})$ to $+(1-10^{-10})$

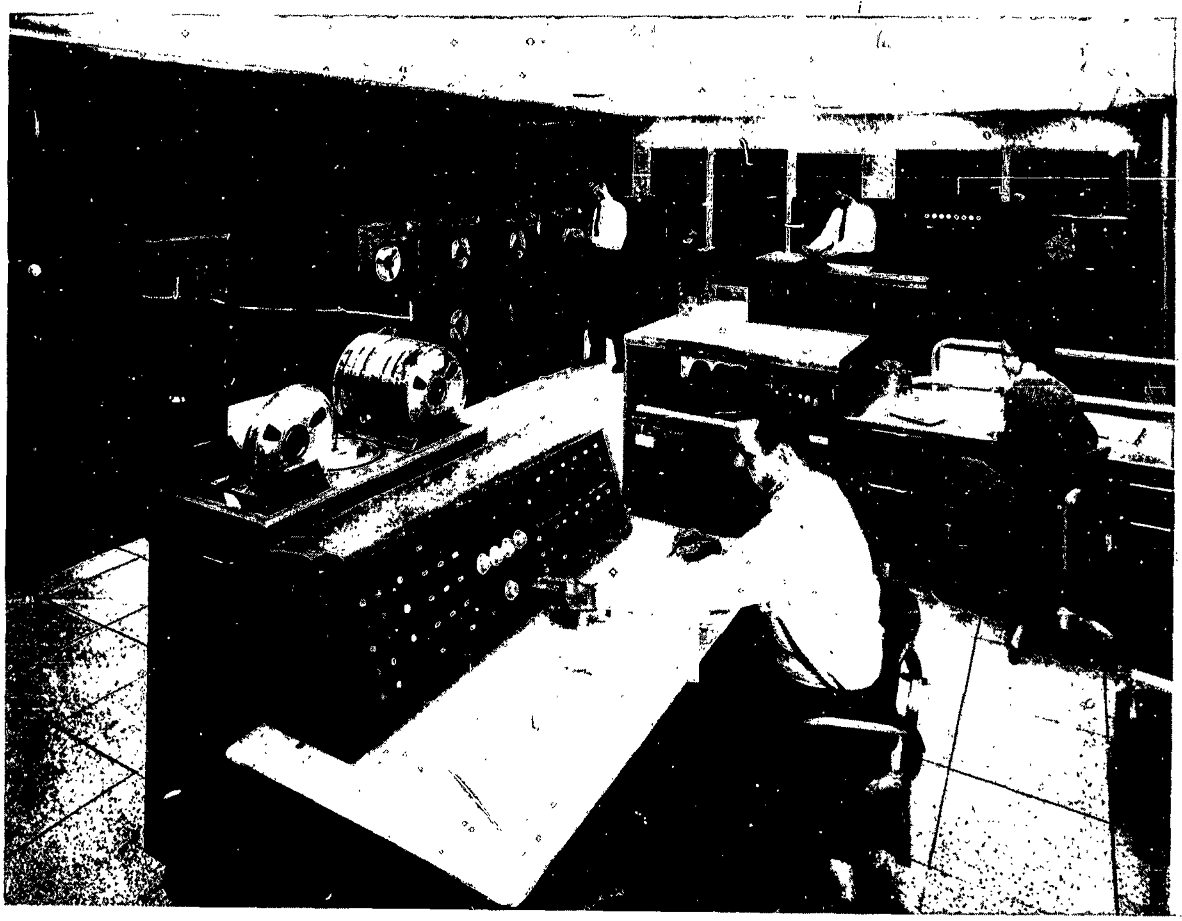


Photo by American United Life Insurance Company

Instruction word format

The command structure of the 304 system is unique in a number of aspects. The instructions are basically 3 address plus a number of other functions or capabilities that are built into the execution of the instruction. The basic instruction word format for arithmetical operations such as add, subtract, etc., is illustrated:

9	8	7	6	5	4	3	2	1	0
Op	A			B			C		
V	M	S	R	Al	Ar	Bl	Br	Cl	Cr

Op = Operation Code

A = Address of Operand

B = Address of Operand

C = Putaway or Jump Address

V = Variation & Self-Linking designator

M = Auto-monitor level

S = Combinations of A, B, or C to be relative to Index Register

R = Index Register

Al, Ar = left and right field of A Address

Bl, Br = left and right field of B Address

Cl, Cr = left and right field of C Address

The programmer in translating procedures for the 304 System will use the NEAT (National's Electronic Autocoding Technique) format. The programmer might write the following to add the Old Quantity on Hand to the Number Received to arrive at the New Quantity on Hand:

ADD (V) (R) OQOH QREC NQOH

The NEAT assembly process will translate the NEAT format into the necessary absolute machine language.

It could be considered that all instructions in the basic 304 Command List are automatic built-in subroutines. There are a number of operation codes that were designed specifically for business data processing such as Edit, Merge, Move, Sift (or table look-up), and Summarize that are powerful instructions and in some cases are self-incrementing.

As an example, the Merge instruction will serve to illustrate the nature of these business-type opera-

Official Marine Corps Photo   Camp Lejeune, N. C.

tions. Specified in NEAT format would be the following mnemonic designators and parameters:

- Designate first word, first item, each string
- Number of items in each string
- Relative position of Major Key (if any), within item
- Relative position of Minor Key within item
- Number of keys (1 or 2) for the Merge
- Length of each item
- Specify three exits (Cutoff Merge only)

NEAT (National's Electronic Autocoding Technique) was in operation before the first deliveries of the National 304 System. This system enables systematic organization in the approach to a problem, an assembly-compiler and a complete library of generators, service programs, and subroutines. COBOL or COBOL-like language will become part of the system in a reasonable time.

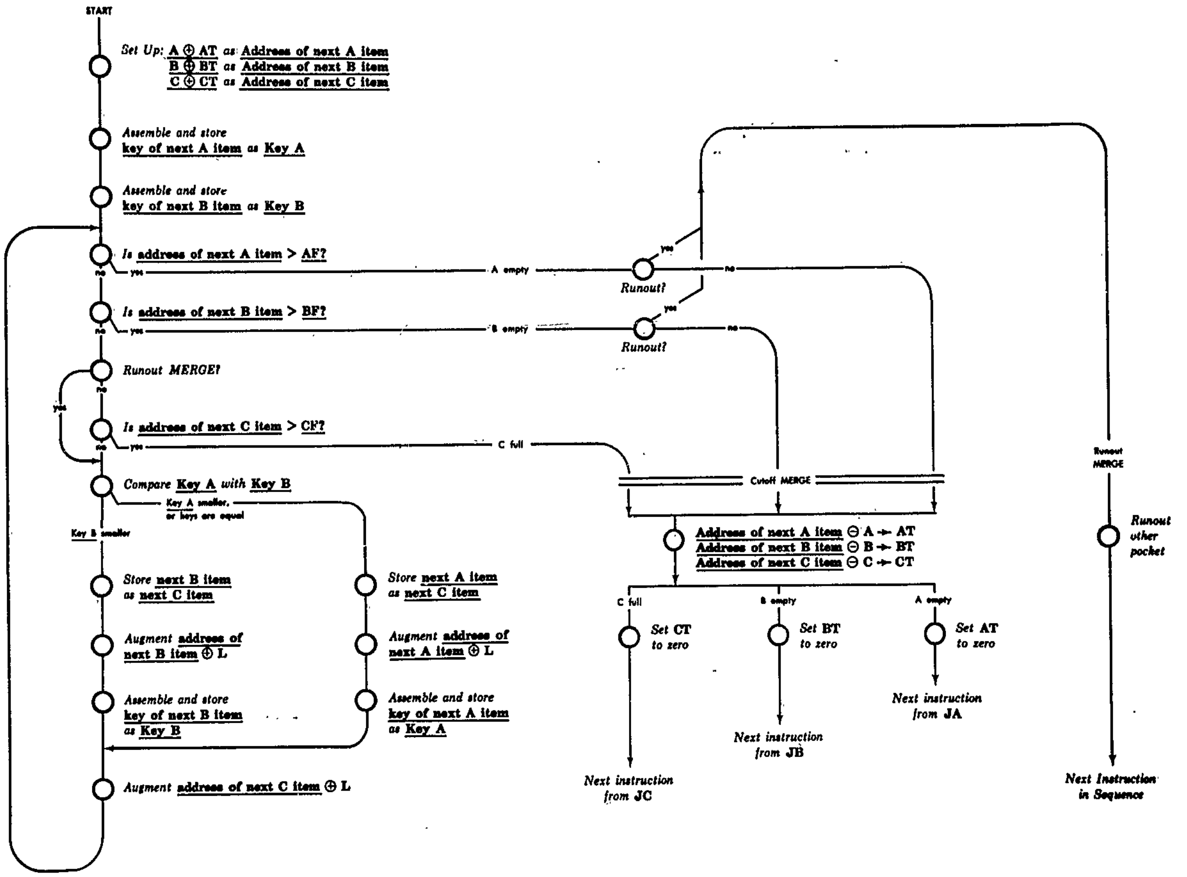
Each instruction may be relative to one of 10 Relative Index Registers. The particular Index Register and the portions of the instruction which are to be relative are specified within the instruction.

ARITHMETIC UNIT

Operation	Incl Stor Access Microsec	Exclud Stor Access Microsec
MICRO-FLOW SINGLE ADDRESS MODE		
Add	120	60
Mult	1,320	1,260
Div	3,480	3,420
BUSINESS-TYPE THREE ADDRESS		
Add	60 (10+R+L)	60 (9+R+L)
Mult	60 (17+R+L+X)	60 (16+R+L+X)
Div	60 (14+R+L+2Q+Y)	60 (13+R+L+2Q+Y)

R = 1 If relative to Index Register
R = 0 If not
L = 2 If self-linking occurs
L = 0 If not
X = Sum plus significant digits of multiplier
Q = Number of digits in quotient
Y = Sum of digits of the quotient

Construction (Arithmetic unit only)
Due to interlaced circuitry, number of elements are included in the total for the 304 Processor.
Arithmetic mode Serial by word, parallel by character
The adder is implemented with two diode-matrix half adders and one diode full adder.
Timing Synchronous in Central Processor
Asynchronous to or from peripheral units



Merge Flow Diagram

Operation	Sequential internally Concurrent with copy or search of magnetic tape or printing

STORAGE

Manufacturer

Media	No. of Words	No. of Alpha-Numeric	Access Microsec
Magnetic Core	2400-4800	24,000-48,000	6/alphanum
Magnetic Tape, per reel	850,000	8,500,000	2 1/2 min

No. of units that can be connected	64 Units
No. of chars/linear inch of tape	200 Chars/inch
Channels or tracks on the tape (including parity and markers)	8 Tracks/tape
Blank tape separating each record	None
Tape speed	150 Inches/sec
Transfer rate (alpha-numeric characters)	30,000 Chars/sec
Start time	3.5 Millisec
Stop time	3.5 Millisec
Average time for experienced operator to change reel	30 Seconds

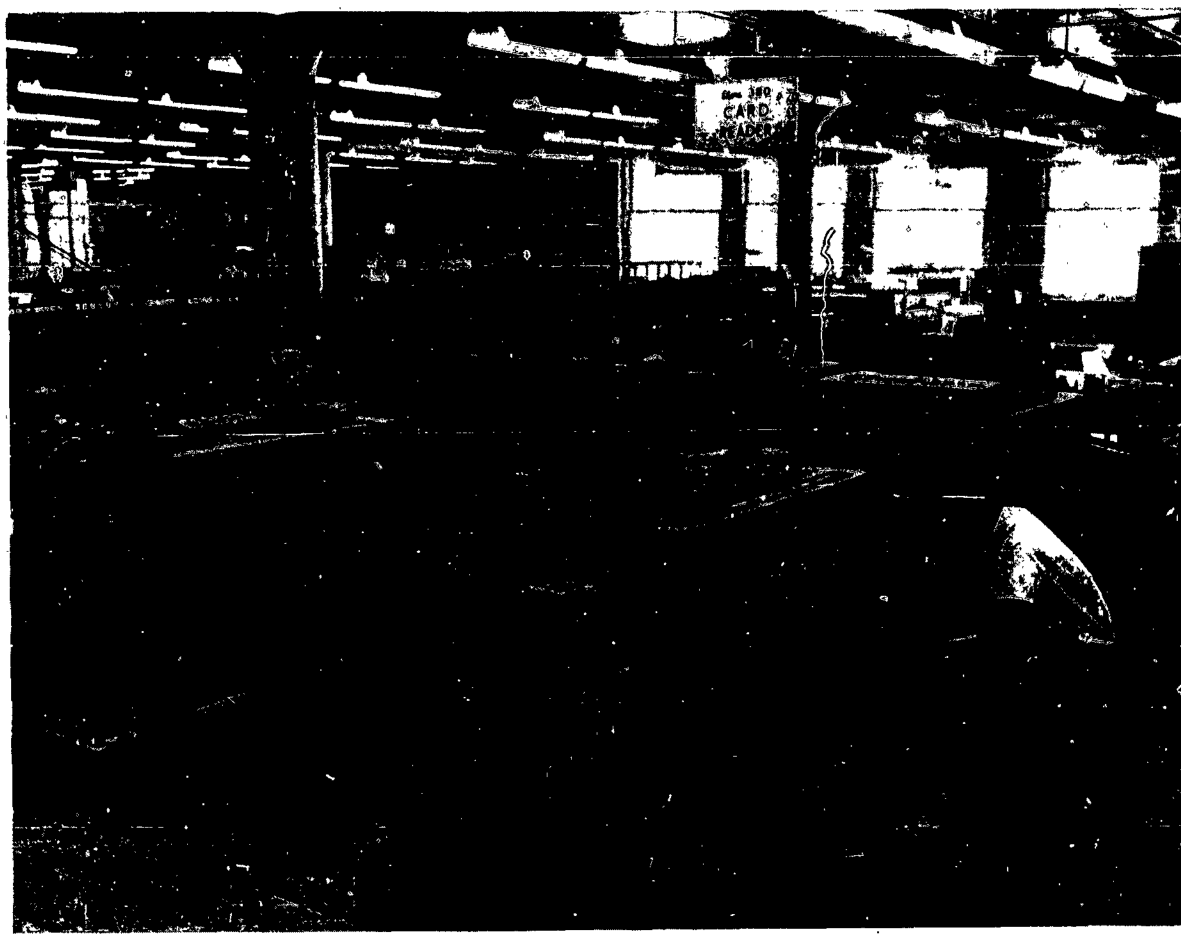
Physical properties of tape

Width	1/2 Inch
Length of reel	3,600 Feet
Composition	1 mil mylar, laminated

The unique 304 magnetic tape system is composed of sub-systems of National 330 Controllers and National 332 Magnetic Tape Handlers. The Central 304 Processor may handle up to eight 330 Controllers, and each Controller may handle up to eight Handlers to provide an upper limit of 64 Handlers available.

A record on magnetic tape may contain 10 or more words. Multiple variable-length records may be written onto magnetic tape with a single acceleration. The contents of one magnetic tape may be read and simultaneously written onto another tape unit until a desired record is reached. The copying may be shared with computing, printing, input or output. Several copy operations may be in progress simultaneously.

All conditions which may arise during magnetic file operations are automatically detected and identified by the Processor without programmed testing. Then a standard routine, called STEP (Standard Tape Executive Program), will perform all tape management



Production — Photo by National Cash Register Company

operations including:

- Repeat in case of error, write "Skip" record after proper number of tries
- Repeat, or jump, on busy Handler or Controller
- Indicate attempt to use locked-out tape
- Alternate Tape Units at end of tape
- Tape identification, and label-checking
- Memory dump, and rescue points
- Log of tape operations
- Executive control over sequencing from one program to the next, or overlays

The time-sharing ability of magnetic tape copy allows for convenient file-splitting, or multi-programming of different jobs where reference to the file is for less than every record. Thus, completely independent programs can be written and checked out, then tied together with the timing interlace being performed by the equipment.

In order to improve the efficiency of Magnetic File Operations, any quantity of numeric information may be packed from 6-bit code to 4-bit code with a single instruction. Thus, utilization of tape storage, and transport speed, will both be increased by 50% for numeric information.

When the packed information is brought into memory, a single instruction will reverse the transformation. Only that information requiring arithmetic operation need be unpacked; sorting, table lookup, and all other logical operations, can be performed on packed information.

U.S. Marine Corps, Camp Lejeune

Medium	No. of Words	No. of Digits	Access Microsec
Core Memory	2400	10	60/word time

U.S. Marine Corps, Camp Pendleton

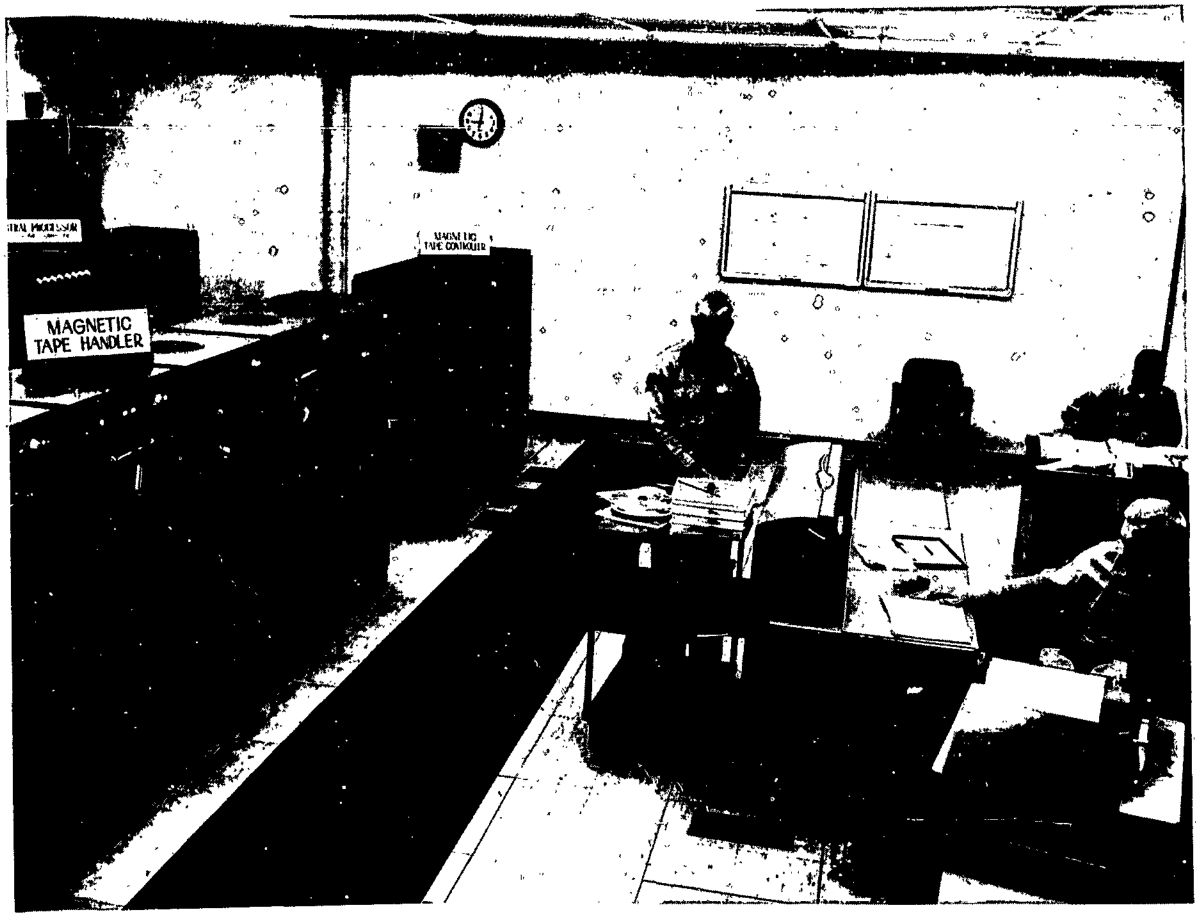
Magnetic Core	2400

U.S Marine Corps, Headquarters

Magnetic Core	2400
Magnetic Tape	864,000

American United Life Insurance Company

Magnetic Core	4800
Magnetic Tape	850,000



Official Marine Corps Photo — Camp Pendleton, California

S. C. Johnson & Son, Inc.

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	2400	10	

National Cash Register Company, Hawthorne

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4800		6/alpha-num char
Magnetic Tape (10 char/word)	1.08 million word/reel		3 min

Bureau of Yards and Docks

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4800	48,000	60

Magnetic Tape may be considered as storage medium.

INPUT

Manufacturer

Media	Speed	
Punched Cards	2000 cards/min	Photo-electric
Punched Paper Tape	1800 char/sec	Photo-electric
Magnetic Tape	30 Kc	alpha-numeric

Punched Cards and Punched Paper Tape may be handled on-line with the 304 Processor or converted to magnetic tape with the 320 Multi-Purpose Converter.

U.S. Marine Corps, Camp Lejeune

Media	Speed
Magnetic Tape	
Punched Cards	
Flexowriter typing	
Flexowriter Paper Tape	

U.S. Marine Corps, Camp Pendleton

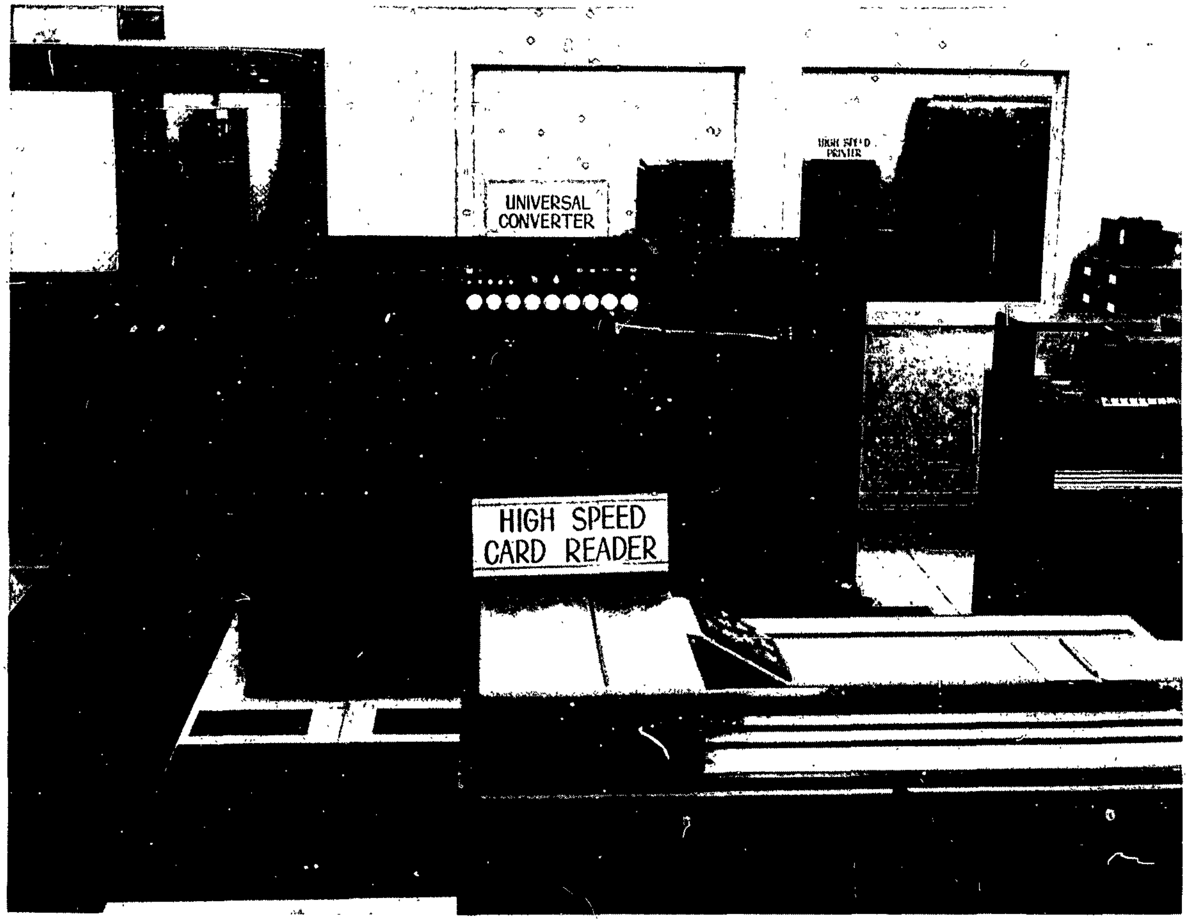
Media	Speed
Magnetic Tape	
Punched Cards	
Console Typewriter	

U.S. Marine Corps, Headquarters

Media	Speed
Magnetic Tape	
Punched Cards	
Punched Paper Tape	
Flexowriter	

American United Life Insurance Company

Media	Speed
Paper Tape Reader	2,000 char/sec
Optical Reader - choice of 3 codes	
Punched Card Reader	2,500 cards/min
90 column cards - read optically	
Magnetic Tape	30,000 char/sec
200 char/in - 3,600' reels	
Console Typewriter	10 char/sec
Modified Flexowriter	



Official Marine Corps Photo

S. C. Johnson & Son, Inc.

Media	Speed
Magnetic Tape	30,000 char/sec
Punched Paper Tape	1,800 char/sec
Punched Cards	2,000 cards/min
Console Flexowriter	10 char/sec

National Cash Register Company, Hawthorne

NCR 380 Card Reader	2,000 cards/min
NCR 360 Paper Tape Reader	1,800 char/sec
Console	10 char/sec
Magnetic Tape	30,000 char/sec

The Paper Tape Reader can handle 6 codes. Three core matrices are on the unit.

Bureau of Yards and Docks

Magnetic Tape	30,000 char/sec
3600 ft = 8.5×10^6 char	
Paper Tape	1,800 char/sec
3 code option, 10 char/in	
Punched Cards	2,000 cards/min
1 card = 80 chars	
Console Typewriter	10 char/sec max.
Manual type-in or paper tape read	

OUTPUT

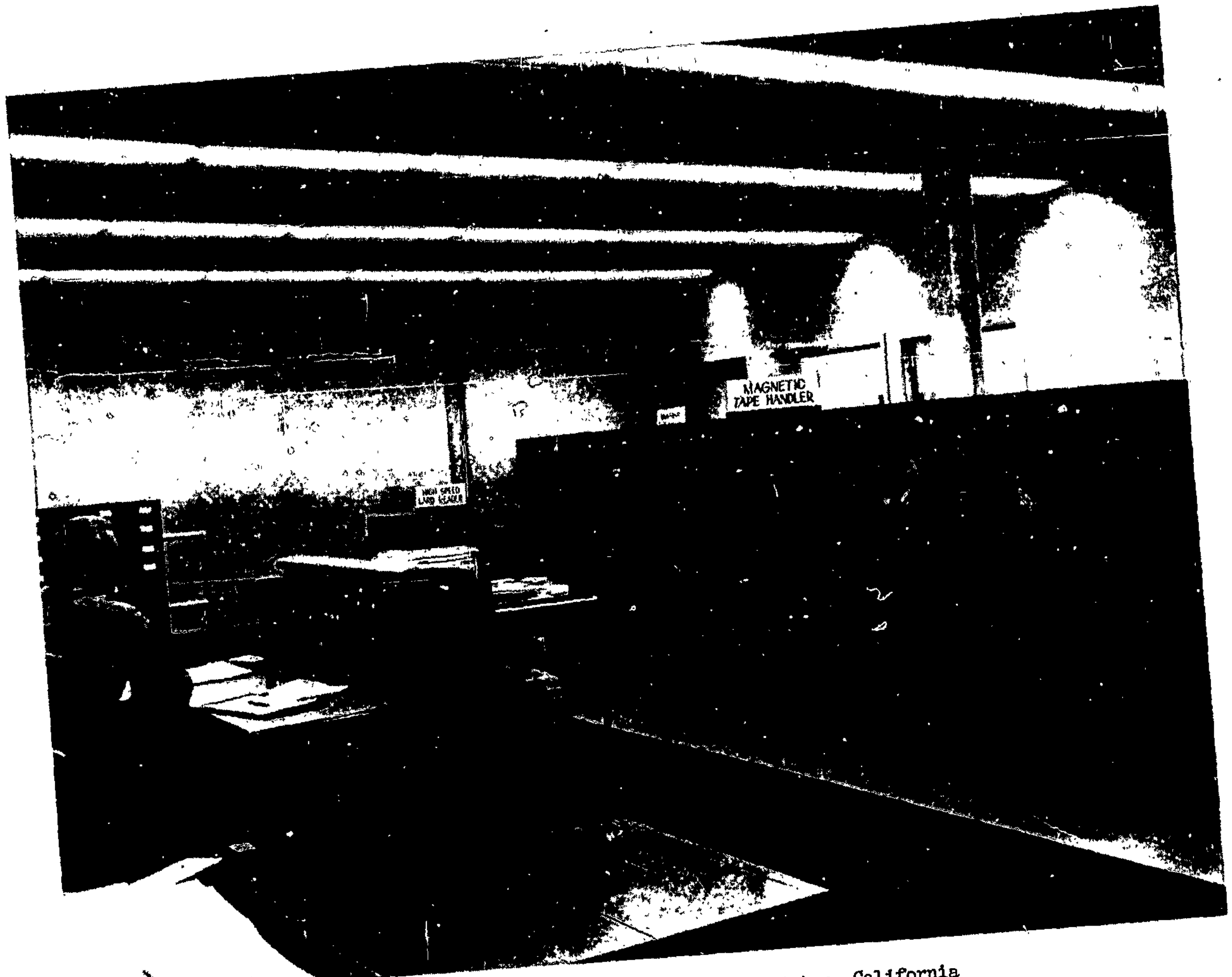
Manufacturer

Media	Speed
Punched Paper Tape	60 char/sec
Line Printer	850-1200 printing 850 alpha numeric 5040 spacing 1200 numeric (lines/min)
Punched Cards	100 cards/min
Magnetic Tape	30,000 char/sec

The Paper Tape Punch or the High Speed Line Printer may be controlled on-line by the 304 Processor or off-line by the 320 Multi-Purpose Converter. The Line Printer may also be controlled off-line by the 322 Printer Converter. Punched cards can be produced off-line using an IBM 523 with source information on magnetic tape and under control of the 320 Converter.

U.S. Marine Corps, Camp Lejeune

Magnetic Tape
Flexowriter typing & punching
Punch Cards
Printer
IBM Type 523 as IBM card output media



Official Marine Corps Photo

Camp Pendleton, California

U.S. Marine Corps, Camp Pendleton

Media	Speed
Printer	
Punched Cards	
Magnetic Tape	
Console Typewriter	

U.S. Marine Corps, Headquarters

Media	Speed
Magnetic Tape	
Printed Reports	
Punched Cards (IBM 523)	
Flexowriter	

Punched card output is always off-line.

Magnetic tape speed is effective speed as there is no gap between records.

American United Life Insurance Company

Media	Speed
*High Speed Printer	600 lines/min alpha-numeric 900 lines/min numeric (1)
Paper Tape Punch	60 char/sec
Magnetic Tape	30,000 char/sec
Post reads all write	
Console Typewriter	10 char/sec

* Interconnecting device permits both on-line and off-line capability. Slews at 4,200 lines/minute.

S. C. Johnson & Son, Inc.

Media	Speed
Magnetic Tape	30,000 char/sec
Punched Paper Tape	60 char/sec
Console Flexowriter	10 char/sec
High Speed Printer	600 lines/min

National Cash Register Company, Hawthorne

Media	Speed
NCR 340 High Speed Line Printer	600-900 lines/min
NCR 370 Punch Paper Tape	60 char/sec
IBM 514 Card Punch	100 cards/min
Magnetic Tape	30,000 char/sec

Card punch is used off line with the 320 Converter.

Bureau of Yards and Docks

Media	Speed
Magnetic Tape 3600 ft = 8.5×10^6 char.	30,000 char/sec
Paper Tape 2 code option, 10 char/in.	120 char/sec
High Speed Printer	600-1200 lines/min
Console Typewriter Machine typeout or paper tape punch	10 char/sec max.

The speed of the High Speed Printer varies and depends on the amount of alphanumerical information to be printed.

Official Marine Corps Photo — Camp Pendleton, California

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	8,000
Transistors	4,000
Magnetic Cores	158,400 - 316,800

24,000 to 48,000 Alpha-numeric characters

The above data applies to the Central Processor only.

CHECKING FEATURES

FIXED

Processor

All transmission of data between the Processor and peripheral units is checked for parity by character, plus echo check for correct number of characters.

All transmission of data in and out of the magnetic core memory is verified by a check character with each word.

Magnetic File Operations

All recording on magnetic tape is immediately checked by re-reading at a check head placed immediately behind the write head. Checks are made for parity on each character, longitudinal parity check over each record, character count on each record, proper bounding of each record, and timing check. These are separate, independent checks with any conceivable out of the ordinary occurrence being detected by at least 2 of these checks.

These same checks are in effect when reading and while the tape to tape transfer (off-line copy) is in progress.

High Speed Paper Tape Reader

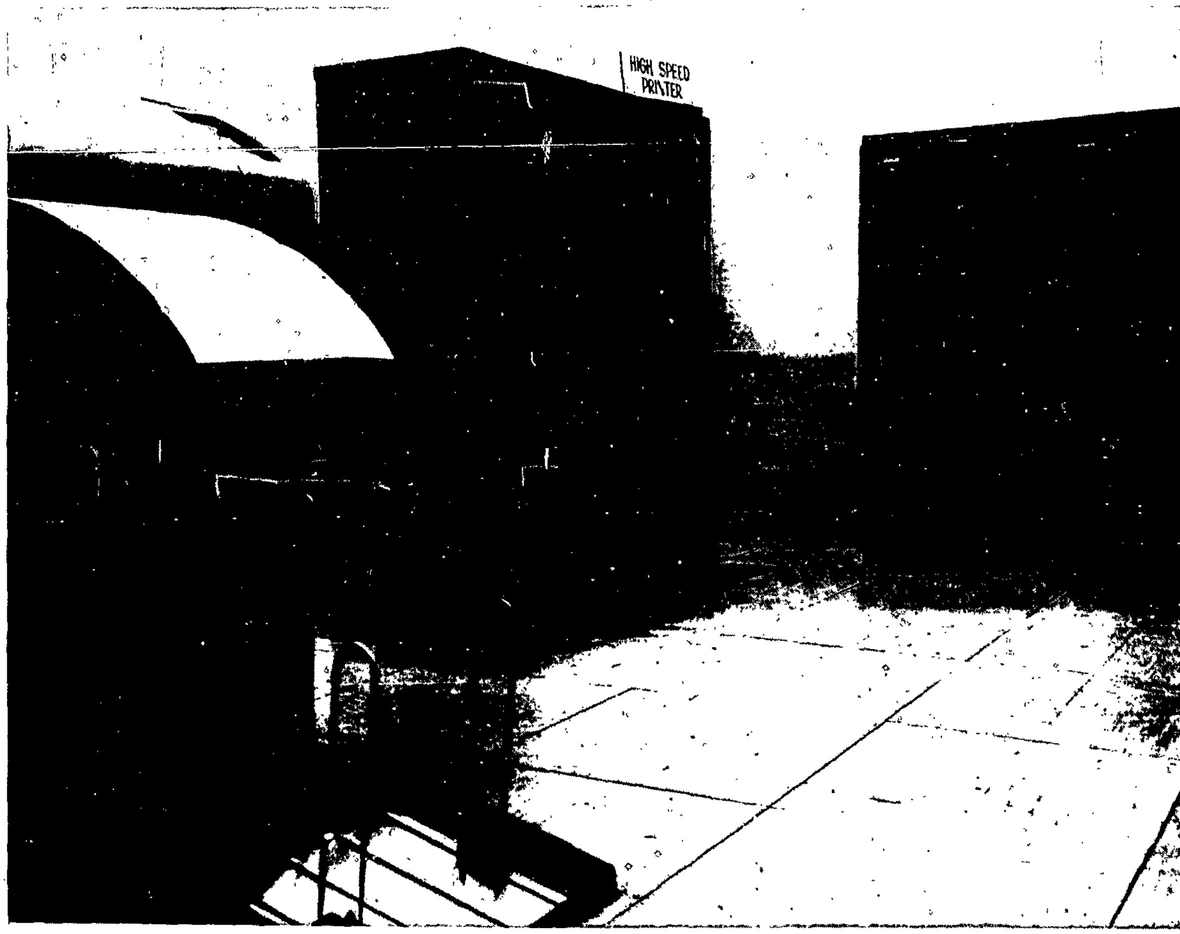
Duplicate photo-electric reading, duplicate translation, error halt on inadmissable characters, are fixed checking features as well as automatic detection of paper tape slippage, undue drifting on stops, and broken tape detection - distinguished from end of tape.

High Speed Card Reader

The fixed checking features are duplicate photo-electric reading and duplicate translation, error halt on inadmissable characters, and also automatic verification of clocking and column count, and detection of out-of-registration or slippage.

High Speed Line Printer

Automatic check for non data characters, correct



Official Marine Corps Photo Camp Pendleton, California

number of characters, correct number printed, and each hammer must fire one and only once per line. Continuous check on the integrity of information stored in the printer buffer during printing, each buffer position printed once and only once-also each hammer. Continuous magnetic reading of special track on print cylinder so that printer electronics "knows" the position of the cylinder with answer-back to printer buffer verifying that the print cylinder position at the moment each hammer is fired is the same as the character stored in the corresponding buffer position. There are two complete individual sets of circuits operating at different voltages-one from buffer positions to activate corresponding hammers and one activated by hammer action back to buffer position. This answer-back verifies not only correct character printed but also that the hammer was fired at the precise instant to print the character clearly and with proper alignment. The vertical format loop will halt the printer if it is parted. Also, all control configurations (15 possible) in the vertical format loop must have even parity, continuously checked.

High Speed Paper Tape Punch
Fixed checking features include echo check off punch dies to verify actual character punched and detection of paper tape exhausted or broken.

OPTIONAL

The Paper Tape Reader and Paper Tape Punch check for character parity on codes that are checkable.
Certain peripheral units contain sequence-controlled circuitry to test for proper operation and insure proper electronic functioning.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer, basic system	38.5 Kw	48.1 KVA	0.8 pf
Power, air condi, package	12 Kw	15 KVA	0.8 pf
Volume, computer	630.2 cu ft		
Area, computer	133.2 sq ft		
Room size	1,200 sq ft		

Above includes basic system with Tape Controller, six Tape Handlers, a Line Printer and a Card Reader.

Volume, air conditioner	400 cu ft
Area, air conditioner	50 sq ft
Room size, computer	120 sq ft

Capacity, air conditioner 15 Tons
Weight, computer 10,850 lbs
Weight, Air conditioner 2,000 lbs
Floor loading 110 lbs/sq ft

Weight is distributed around perimeter of frames.

Site preparation requirements

The specific site preparation requirements will vary from installation to installation, depending on available facilities, "show case" considerations, and policy.

General requirements for physical environment include air conditioning, humidity control, and provisions for maintenance of equipment. There can be flexibility in construction as pertains to the use of false flooring, ceilings, or conduits. It is usually recommended that false flooring be used, as the area under the false floor serves the dual purpose of protecting cables and eliminates supply ducts for conditioned air. A false ceiling eliminates the need for return ducts. The power specifications call for 120/208 volts, three-phase, four wire, 60 cycles.

U.S. Marine Corps, Camp Lejeune

Power, computer	43.76 Kw	54.7 KVA	0.8 pf
400 N Power	18.24 Kw	22.8 KVA	
Power, air cond	11.0 Kw	12.2 KVA	
Volume, computer		630 cu ft	
Volume, air conditioner		32,630 cu ft	
Area, computer		147 sq ft	
Area, air conditioner		2,190 sq ft	
Capacity, air conditioner		27 Tons	
Weight, computer		15,000 lbs	
Weight, air conditioner		5,000 lbs	

Air conditioning space partitioned off from existing warehouse. False ceiling and new raised-floor designed expressly for computer installation was provided. A remote installation including compressors, air handling units, and evaporative condenser was installed. A new electrical service including 225 KVA transformers capacity installed.

U.S. Marine Corps, Camp Pendleton

Power, computer	35.5 Kw	44.4 KVA	0.8 pf
Power, air condi	32.2 Kw	40.4 KVA	0.8 pf
Volume, computer		635.2 cu ft	
Volume, air conditioner		455 cu ft*	
Area, computer		147.0 sq ft	
Area, air conditioner		51 sq ft*	
Room size, computer		1,860 sq ft	
Room size, air conditioner		350 sq ft	
Floor loading		96 lbs/sq ft (Avg)	
		155 lbs concen max	
Capacity, air conditioner		25 Tons	
Weight, computer		13,150 lbs	
Weight, air conditioner		7,200	

*Does not include air filtering equipment or input/output plenums.

Site is located in a warehouse building. False ceiling, false flooring, air conditioning, power substation installed. Data Processing Installation covers 14,000 sq ft and includes EAM equipment, office space, card and paper storage space, rest rooms, as well as NCR 304 EDP Equipment. Total cost $175,000.

U.S. Marine Corps, Headquarters

Power, computer	46.48 Kw	58.1 KVA	0.8 pf
60 CPS and 400 CPS.			
Power, air condi	28 Kw	35 KVA	0.8 pf
Volume, computer		15,200 cu ft	
Volume, air conditioner		3,360 cu ft	
Area, computer		1,900 sq ft	
area, air conditioner		280 sq ft	
Room size		Between 1600 and 2000 sq ft	
Floor loading		250 lbs/sq ft	
Floor loading, computer		100 lbs/sq ft	
Capacity		25 Tons	
Weight, computer		12,950 lbs	

Site was installed in a brick building with concrete floors. Completely overhead air conditioning delivery concealed by false ceiling. Raised false flooring for concealment of power and logic cables.

American United Life Insurance Company

Power, computer (basic system)	38.5 Kw	48.1 KVA	0.8 pf
Volume, computer		650 cu ft	
Volume, air conditioner		600 cu ft	
Area, computer		150 sq ft	
Area, air conditioner		200 sq ft	
Room size, computer		2,000 sq ft	
Room size, air conditioner		600 sq ft	
Floor loading		110 lbs/sq ft	
Capacity, air conditioner		30 Tons	
Weight, computer		11,000 lbs	
Weight, air conditioner		3,000 lbs	

Site preparation requirements

Due to the physical structure of the existing building, the location of the computer area within the building, and the requirement for a separate air-conditioning system, the following additions and modifications were made at this site. A 30 ton air-conditioning and air handling system was installed composed of three ten ton chilled-water coolers and an air handling system capable of moving 9,000 cubic feet of air per minute. This system provided for automatic temperature and humidity controls geared to control the computer room to 40% relative humidity and 74°F temperature. The control system was built around Johnson Controls with Bristol seven-day recording devices. Air was delivered directly under the raised floor with dampered registers around the periphery of the room to properly distribute the incoming conditioned air. Return air was vented through the ceiling in registers into an air plenum between the false ceiling and the existing ceiling and returned to the air-conditioning equipment. The raised floor was set ten inches above the concrete slab. The false ceiling was installed eight and one-half feet above the raised floor, and in the location selected was twenty inches below the previously existing ceiling. A masonry wall was contructed two feet inside the existing brick and masonry walls of the building and supplemented by movable steel and glass partitions where the room was divided away from exterior walls. The raised floor is of cast aluminum in sections eighteen inches square with a vinyl floor covering. Power and water were delivered to the equipment room from existing central supply within the building itself. The computer area itself has been equipped with Muzak installation and an intercommunicating system utilizing the existing speakers.

S. C. Johnson & Son, Inc.

Power, computer	70 KVA
Power, air conditioner	20 KVA
Volume, computer	740 cu ft
Area, computer	160 sq ft
Area, air conditioner	300 sq ft
Room size, computer	1,300 sq ft
Room size, air conditioner	700 sq ft
Capacity, air conditioner	20 Tons

Site preparation included trenching of floor to provide ducts and cable to equipment.

National Cash Register Company, Hawthorne

Power, computer	44 Kw	55 KVA	0.8 pf
Power, air condition	24 Kw	30 KVA	0.8 pf
Volume, computer		790 cu ft	
Volume, air conditioner		800 cu ft	
Area, computer		166 sq ft	
Area, air conditioner		100 sq ft	
Room size, computer		1,800 sq ft	
Room size, air conditioner		240 sq ft	
Floor loading		110 lbs/sq ft	
Capacity, air conditioner		30 Tons	
Weight, computer		13,560 lbs	
Weight, air conditioner		4,000 lbs	

Site included along with construction of new building in 1956. False flooring has been installed to support a 304, 320, 330, 9-332s, 340, 360,370, 380, and 514.

Bureau of Yards and Docks

Power, computer	32.0 Kw	40 KVA	70% min pf
Volume, computer		10,440 cu ft	
Volume, air conditioner		4,536 cu ft	
Area, computer		1,305 sq ft	
Area, air conditioner		432 sq ft	
Room size, computer		59 ft 4 in long	
		22 ft 0 in wide	
		8 ft 0 in high	
Room size, air conditioner		12 ft 4 in wide	
		35 ft 0 in long	
		10 ft 5 in high	
Floor loading		250 lbs/sq ft	
Capacity, air conditioner		30 Tons	
Weight, computer		12,950 lbs	

New cinder block building of 2,556 square feet was built to house the data processor.

PRODUCTION RECORD

Number produced to date	6
Number in current operation	6
Number in current production	14
Number on order	23
Anticipated production rates	2 per month
Time required for delivery	18 months

COST, PRICE AND RENTAL RATES

Manufacturer

Model No.	Component	Monthly Rental	Purchase Price
304	Data Processor including Control Console (2,000 Word Memory plus 400 Special Words)	$5,730	$366,600
304	Data Processor including Control Console (4,000 Word Memory plus 800 Special Words)	6,560	420,000
304-2	Data Processor including Control Console (2,000 Word Memory plus 400 Special Words); with Micro-Flow, Magnetic Character Input, & Multiple Printer Output	6,240	399,200
304-2	Data Processor including Control Console (4,000 Word Memory plus 800 Special Words); with Micro-Flow, Magnetic Character Input, & Multiple Printer Output	7,070	452,600
320	Universal Off-line Converter	$1,970	$126,000
322	Off-line Printer Converter	710	45,000
330	Magnetic Tape Controller - 30 KC	1,740	111,000
332	Magnetic Tape Handler-30 KC	415	26,300
340	High-Speed Line Printer	1,940	124,300
340-2	High-Speed Line Printer	1,970	126,225
351	Typewriter Printer (Extra)	70	3,400
354-2	Card Punch Buffer	600	28,800
355-2	Sorter Buffer	700	33,550
360	High-Speed Paper Tape Reader	510	32,800
370	High-Speed Paper Tape Punch	280	17,800
380	High-Speed Punched Card Reader	490	31,100
402-1	Magnetic Character Sorter	1,700	62,000

Maintenance/Service Contracting

Maintenance and service will be furnished to suit the individual needs and schedules of each installation. On lease arrangements, the cost of maintenance is included in the rental rates. Where the equipment is purchased, a maintenance contract is available.

U.S. Marine Corps, Camp Lejeune
Basic System

	Components	Monthly Rental 1 Jul60 - 30Jun 61
304	Data Processor including Console (2400 word memory)	$5,730
320	Universal Converter	1,970
340	High Speed Printer	1,940
330	Magnetic Tape Controller	1,740
380	High Speed Punched Card Reader	490
332	Magnetic Tape Handler at $520.00 each	
	at $415.00 each	2,075
		$13,945
	Additional Equipment	
	Type 523 Summary Punch	$ 75

Maintenance and service provided by contractor at no additional charge when renting.

U.S. Marine Corps, Camp Pendleton

Rental contracting and rates for basic system
Monthly rental rate effective 1 July 1960 - $13,945.
304 Data Processor (1) $5730 - 330 Mag Tape Controller (1) $1740 - 340 Printer $1940 - 320 Converter (1) $1970 - 332 Mag Tape Handler (5) $2075 - 380 Card Reader $490.
Additional equipment
IBM 523 Card Punch - $88 per month.

Maintenance performed by NCR personnel; cost included in monthly rental.

U.S. Marine Corps, Headquarters

		Eff 1 Jul 60
304	Data Processor including Console (2400 word memory)	$5,730
320	Universal Converter	1,970
340	High Speed Printer	1,940
330	Magnetic Tape Controller	1,740
332	Magnetic Tape Handler, 8 at $415.00 each	3,320
380	High Speed Punched Card Reader	490
523	IBM Gang Summary Punch	85
	Total monthly rental for 176 hours usage	$15,275

Maintenance and service contracting included in rental costs.

S. C. Johnson & Son, Inc.

	Component	Price
304	Processor including Console	$356,800
330	Controller	111,000
340	Printer	109,400
322	Printer Controller	37,300
332	Magnetic Tape Unit (9)	204,300
360	Paper Tape Reader	19,600
370	Paper Tape Punch	15,700
		$854,100

National Cash Register Company, Hawthorne Monthly rental contracting and rates for basic system are 304 Processor (4800 words) $6560 - 320 Multi Purpose Converter $1970 - 330 Mag. Tape Controller $1740 - 370 Paper Tape Punch $280 - 380 Punched Card Reader $490 - Nine (9) Mag. Tape Handlers at $415 each $3735 - 340 High Speed Line Printer $1940 and a 360 Paper Tape Reader $510.

Additional equipment includes a Universal Interconnecting Device and a Paper Tape Rewinder and Splicer.

Bureau of Yards and Docks

	Monthly Rental
Data Processor	$6,560
Magnetic Tape Controller - 30 Kc	1,740
Magnetic Tape Handler - 30 Kc	2,905
High Speed Line Printer	1,940
Add. Typewriter Printer	70
High Speed Paper Tape Reader	510
High Speed Paper Tape Punch	280
High Speed Punched Card Reader	490
Total Approximate Monthly Rent	$14,495

PERSONNEL REQUIREMENTS

Manufacturer

Since the National 304 System is a new system with the first installation in November, 1959, at the present writing it is difficult to determine normal personnel requirements. It is anticipated that the advanced solid-state design and overall system fabrication will result in most favorable operating experience. The early performance of the initial systems has borne this out.

It is expected that a typical 304 System can be maintained by 3 or 4 engineer-technicians. Two and three shift operation will require some increase.

Training made available by manufacturer to users includes initial and turnover replacement training and executive orientation. These are provided at no cost to the user at mutually agreeable locations.

U.S. Marine Corps, Camp Lejeune

	One 8-Hour Shift Used	One 8-Hour Shift Recommended
Supervisors	1	1
Programmers	3	5
Librarians	2	2
Operators	3	4
Engineers	6	6
Tape Handlers	2	2

Contractor provides Programmer School periodically. Contractor provides representative to assist in initial stages of implementation.

U.S. Marine Corps, Camp Pendleton

	One 8-Hour Shift Used	One 8-Hour Shift Recomm	Two 8-Hour Shifts Recommended	Three 8-Hour Shifts Recommended
Supervisors		*	**	**
Analysts	1	1*		
Programmers	3	3	3-Prim only	3-Prim only
Librarians	2	2	1 per shift	1 per shift ***
Operators	3	3	2-Prim; 1-2d	1 per shift
Tape Handlers	2	2	1 per shift	1 per shift ***

All of our programmers, operators, and tape handlers are equally proficient at programming and operating and we intend to perpetuate this versatility. Librarians are trained on the job for programmer/operator work.

* - Officer-in-charge and Supervisor on Prime Shift.

** - Senior Enlisted Programmer/Operator present is Shift Supervisor.

*** - Requires increase in T/O of one person.

Operation tends toward closed shop.

Methods of training used includes formal training by manufacturer and on-the-job training at the site.

U.S. Marine Corps, Headquarters

	One 8-Hour Shift Used	One 8-Hour Shift Recom	Two 8-Hour Shifts Recommended	Three 8-Hour Shifts Recommended
Supervisors	1	1	1	1
Librarians	1	1		
Operators	1	1	1	1
Engineers	7	7	0	
In-Output Oper	1	1	1	1
Tape Handler	2	2	2	2

Above personnel requirements are shown for Computer System operating personnel only. The number of analysts programmers, coders and clerks is dependent on the peculiarities of the accounting or reporting system to be placed on the computer.

The number of engineers presently being used to operate one shift would stay the same if the operating period was expanded to two shifts. For a three shift operation engineers would be on an "on-call" basis for the third shift.

Operation tends toward open shop.

Methods of training used includes Equipment Manufacturers School and on-the-job training for operating personnel.

American United Life Insurance Company

	One 8-Hour Shift
Supervisors	1
Analysts, Prog. & Coders	7
Clerks	1
Librarians	1
Operators	2
Engineers	NCR
Technicians	NCR
In-Output Oper	24
Tape Handlers	2

Since the equipment was installed only on 2 May 60, and because it has been used primarily for program testing, it is impossible to make intelligent personnel distributions. Since production operating time is required for information of this type it will be some time before valid figures can be accumulated.

Operation tends toward open shop.

Methods of training used include two methods, a formalized programming school, instruction for which was provided by The National Cash Register Company, and on-the-job training for the additional personnel

required. The training of operating personnel was handled by the user with the advice of the manufacturer as required.

S. C. Johnson & Son, Inc.

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors	1	1
Librarians	1	2
Operators	1	2
In-Output Oper	1	2
Tape Handlers	1	2

Operation tends toward open shop.

Methods of training includes on-the-job training and a Programming School.

The above pertains to requirements for operations.

Systems and Programming Staff for maintenance of existing system and future applications consists of 1 Program Supervisor, 4 Programmers, 1 System Planning Coordinator, and 2 Systems Men.

National Cash Register Company, Hawthorne

	One 8-Hour Shift
Supervisors	1
Programmers - Analysts - Coders	15
Clerks	2
Operators	2
Engineers-Technicians	6
In-Output Oper	1

Operation tends toward closed shop.

Methods of training used includes programming courses and on-the-job training.

Bureau of Yards and Docks

	One 8-Hour Shift Used	One 8-Hour Shift Recommended
Supervisors	4	
Analysts	7	8
Programmers	7	12
Clerks		1
Librarians		1
Operators	1	4

Operation tends toward closed shop.

Training classes have been held on site.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Reliability and optimum operating experience were basic design objectives with the 304 System. The latest electronic developments and solid state devices have been used throughout. Design tolerances are set beyond those of "worst case" conditions of heat, voltage fluctuation and aging. Standardized plug-in cards are used throughout as well as etched circuit back panels to replace wiring harnesses and cables.

Units are separately powered and contain circuitry which performs a sequence of automatic reliability tests to insure proper operation or to isolate for replacement of circuit cards.

Individual units have extensive features to insure reliability as stated in Checking Features. The High Speed Paper Tape Reader and the High Speed Paper Tape Punch which can handle different codes by switch selection, have a programmable check on the proper code. A mode of the Test instruction can insure that the proper switch is set.

U.S. Marine Corps, Camp Lejeune

Good time 45.6 Hours/Week (Average)
Attempted to run time 52.2 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.87
Above figures based on period 1 Apr 60 to 29 Apr 60
Passed Customer Acceptance Test 4 Mar 60
Time is not available for rent to outside organizations.

During period measured above the system was not afforded perfect temperature and humidity environment due to air conditioning equipment deficiency.

Break-down of Computer time - April 1960

Primary Shift	241.0 Hrs
Production (*)	182.5 Hrs
Down	10.8 Hrs
Idle	22.1 Hrs
Re-run	25.6 Hrs

* Production total breaks down as follows:

Operational Use Time for Rental Purpose	161.3 Hrs
Lunch Time Opr, not subject to rental	7.4 Hrs
Set-up Time, not subject to rental	13.8 Hrs

U.S. Marine Corps, Camp Pendleton

Average error-free running period 39.48 Hours
Good time 36.5 Hours/Week (Average)
Attempted to run time .48 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 76 to 1
Above figures based on period 1 Feb 60 to 30 Apr 60
Passed Customer Acceptance Test 14 Jan 60
Time on 2d and 3d shifts is available for rental to outside organizations.

U.S. Marine Corps, Headquarters

Time will be made available to other government agencies only and on a pro-rated cost basis. Time will be on an "as available" basis.

System was turned over for Marine Corps use on 12 May 60.

American United Life Insurance Company

Average error-free running period 2 weeks +
Good time 79.3 Hours/Week (Average)
Attempted to run time 80 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.991
Above figures based on period 2 May 60 to 25 May 60
Passed Customer Acceptance Test 2 May 60
Time is not available for rent to outside organizations.

The amount of time available for the accumulation of the information requested is too short to prove of much validity. The experience to date has shown that the system is surprisingly solid and that a high ratio of operating time can be expected.

S. C. Johnson & Son, Inc.

Passed Customer Acceptance Test 10 Jun 60
Time is available for rent to outside organizations.

Bureau of Yards and Docks

Good time 294 Hours
Attempted to run time 302 Hours
Operating ratio (Good/Attempted to run time) 0.9733
Above figures based on period 11 Jul 60 to 9 Aug 60
Passed Customer Acceptance Test 11 Aug 60
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include a magnetic tape system which is gapless, with timesharing of off-line tape-to-tape transfer (copy) while searching. High Inputs-Paper Tape - 1800 cps. Punched cards fed at 2000 cpm. Command structure is powerful for ease of coding and debugging.

The 304 System has complete off-line conversion facilities - for input and output transcribing. However, the input speeds of 1800 characters per second for paper tape and 2000 punched cards per minute are so favorable that many businesses will find it unnecessary to go through off-line input conversion. For example, 30,000 transactions of 30 characters each would require only eight and one-half minutes of processing time when reading paper tape on-line. Transcribed transactions could be read from magnetic tape by the Processor in about one half a minute. So the off-line input conversion would not save more than eight minutes a day.

An extensive library of programs were accomplished and ready for use with the installation of the first 304 System. National's Electronic Autocoding Technique --NEAT-- was developed to reduce coding costs and to simplify programming. The purpose of NEAT is to simplify the transition from flow chart to machine code without losing any of the flexibility and power of the actual 304 instructions. It enables systematic organization to a problem. Coding in NEAT can be thought of as the translation of a 304 flow chart into pseudo instructions, employing mnemonic addressing. The result of processing NEAT on a 304 computer, is a completed machine code, which may be produced on magnetic tape, punched cards, or punched paper tape. In the course of the computer run, automatic code checking is done for obvious inconsistencies. COBOL or COBOL-like language is being added to the NEAT process. STEP, the program which takes advantage of the internal logic to handle magnetic file housekeeping, is also in operation. Other programs that are available are a Sort Generator, Librarian, monitoring, tracing, and programs to facilitate program check-out.

Procedures for magnetic tape labelling, storing, shipping, and protection from humidity, temperature, electrical, fire, or other damage are the normal procedures and care that are customary for mylar-magnetic tape.

U.S. Marine Corps, Camp Lejeune

Outstanding features include off-line copy operation for simultaneous processing and read/write, maximum storage of data per reel of tape, and high speed card reading.

Unique system advantages include ease of operation by means of a console, which gives system control and components with a minimum number of controls, a 320 Multipurpose Converter for off-line operations, NEAT - a coding technique, which simplifies programming, and a monitor feature which simplifies code-checking.

Tape labelling is performed by means of STEP, (Standard Tape Executive Program), which labels tape and checks obsolescence of tapes before use.

U.S. Marine Corps, Camp Pendleton

Outstanding features are high speed card reader, high speed printer, and transistorized solid state computer.

Unique system advantages are no inter record gap on magnetic tape and a built-in business command structure.

Procedures have been adopted for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage. Two labels are used; one containing permanent identification, and the other containing information of a temporary nature. Tape is stored in a library which is temperature and humidity controlled. A semi-automatic CO_2 system has been installed for fire protection. A fire proof safe will be used to house Historical Tapes.

U.S. Marine Corps, Headquarters

Outstanding features include no inter-record gaps on tape. This allows an effective read-write speed of 30 K per second, and the ability to address any character or number of characters of a word in storage.

Unique system advantages include transistorized components, which bring about low power and air conditioning requirements, and thereby reduces installation costs.

Procedures have been adopted for magnetic tape labelling, storage, shipping, and protection from himidity, temperature and physical, electrical, fire, or other damage. Tapes are stored in an air conditioned area. Shipment of tape is made in "netic" containers. Any two of three installations can reconstruct tapes of the third. Both outside labelling on reel and writing on tape for positive identification of all records is performed.

American United Life Insurance Company

The NCR 304 System features matched cabinets, console simplicity, input-output computing compatibility, operating ease, transistorized construction, interchangeable components, and up-to-date design philosophy.

The system features variable record length, dual search capability, absence of inter-record gaps, read-back of write magnetic tape, built-in magnetic tape executive routines, mnemonic autocoding techniques, and full checking devices for input, output, and computing.

Procedures have been adopted for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage. These procedures defy brief description but are available for those interested upon request.

The general design and philosophy of the NCR 304 System is based upon the known and proven requirements of business and industry. The philosophy of the system and the compatibility of input, output, and computing make it possible to obtain the maximum amount of flexibility in the operating procedures of the using organization.

National Cash Register Company, Hawthorne

Outstanding features include high input speeds, ease of programming, console designed for operator, and a magnetic tape system.

Unique system advantages include a gap-less magnetic tape system, off line copy, automatic read back after write. STEP-combination of circuitry and programming to handle magnetic tape housekeeping. NEAT Autocoding System - COBOL being incorporated. Emphasis on reliability and checking of data movements.

Normal procedures for properly handling mylar magnetic tape have been adopted.

This was the first in operation of the several National Data Processing Centers. There is a 304 Center in New York City and a Center in Dayton, Ohio.

Bureau of Yards and Docks

Outstanding features include ease of programming and program testing.

A procedure for labelling, storage, temperature and humidity protection and fire has been adopted.

FUTURE PLANS

Manufacturer

While retaining all of the previous features and specifications of the initial 304, an improved model will be available starting in the Fall of 1960. The Central Processor has been designated as the 304-2, and will have MICRO-FLOW, Magnetic Character Input, and allow multiple high speed line printing as output.

MICRO-FLOW is a new mode of single-address operation that essentially expands the instruction repertoire from 37 to 104 instructions. This new mode of operation does not in any way supplant the powerful, business-type instructions. MICRO-FLOW is designed for scientific computation, permitting fixed or floating point arithmetic, and for areas of operation when the single-address mode might be faster or more efficient. The single-address MICRO-FLOW and the three-address business-type instructions may be intermixed within a single program, switching from one to the other to provide the most efficiency.

Magnetic Character Input can be provided with the use of the 304-2 Central Processor in conjunction with the National 402-1 Magnetic Character Sorter. Checks or documents encoded with magnetic ink characters may be read at the rate of 750 documents per minute. There will be input of the information into the Processor memory, control over pocket selection, and jump table control for unusual situations. The Magnetic Character Sorter can be used off-line to sort documents as controlled by a panel on the Sorter.

For high-volume output operations, the 304-2 Central Processor will enable multiple printers on-line, up to four National 340 High Speed Line Printers. Buffering and Busy Jumps will enable a maximum of time-sharing.

U.S. Marine Corps, Camp Pendleton

It is proposed that the number of NCR 332 Magnetic Tape Handlers be increased from 5 to 8, that the NCR 304 Memory Size be increased from 2,400 to 4,800 words, i.e., 24,000 to 48,000 characters, and that the number of computer applications be increased from Personnel Accounting only, to that of Fiscal Accounting (including Disbursing functions) and local Supply Accounting.

American United Life Insurance Company

Future plans with regard to this system include the possibility, at the proper time, of expanding the existing system to include additional magnetic tape units, and perhaps another high speed printer. Procedurally new applications will be added as desired. We are looking forward to performing operations on research, market analysis, and a more thorough analysis of sales and determining standards of sales performance.

INSTALLATIONS

U. S. Marine Corps Base
Camp Lejeune, North Carolina

U. S. Marine Corps Base
Camp Pendleton, California

U. S. Marine Corps, Headquarters
Washington 25, D. C.

Bureau of Yards and Docks
Department of the Navy
Washington 25, D. C.

American United Life Insurance Company
Indianapolis, Indiana

The National Cash Register Company
Hawthorne, California

S. C. Johnson & Son, Inc.
Racine, Wisconsin

U. S. Navy New York Naval Shipyard
Brooklyn 1, New York (Proposed)

U. S. Air Force, Headquarters, Strategic Air Command
Offutt Air Force Base, Nebraska

NATIONAL 315

MANUFACTURER

The National Cash Register Company

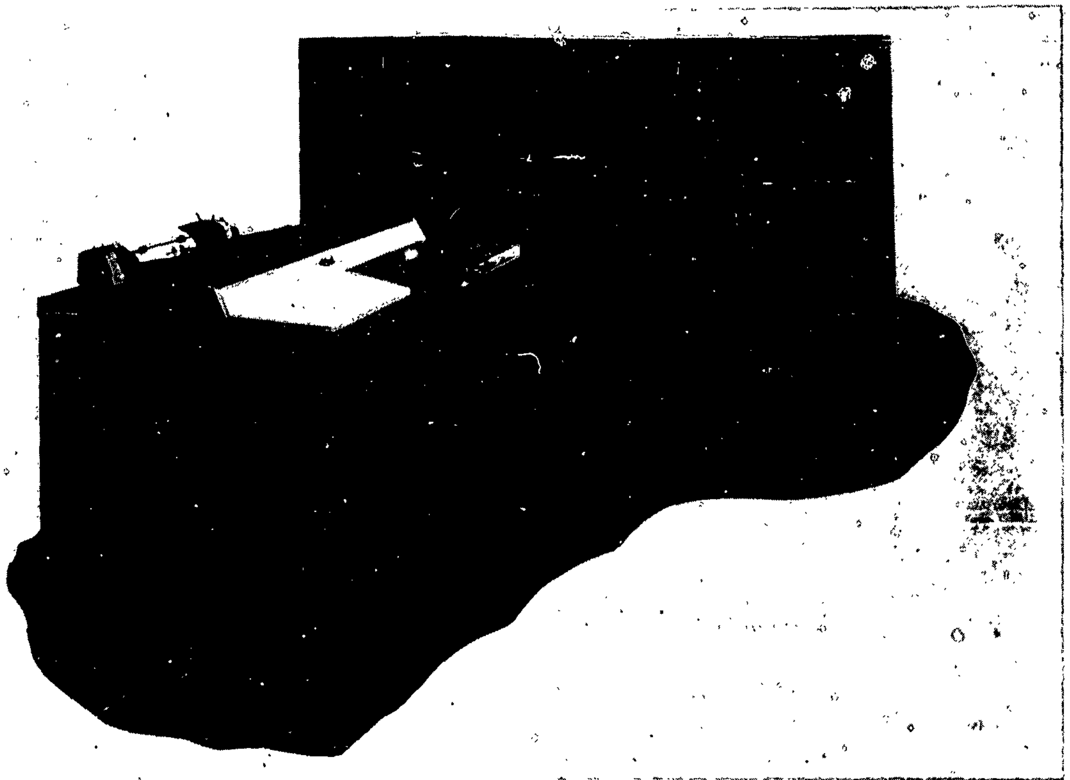


Photo by the National Cash Register Company

APPLICATIONS

The National 315 System has broad application in all types of business and scientific data processing. Modular assembly of components permits a wide range of system organization from low-cost systems up to large-scale capabilities. New design concepts and features provide maximum versatility and flexibility in application.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	3 (or 2 alphanumeric characters)
Decimal digits/instruction	6
Words/instruction	2 or 4
Instructions decoded	90 plus variations
Arithmetic system	Fixed point (Field lengths up to 24 digits)
Instruction type	One-address-roughly 1/3 of instruction list Two address- roughly 2/3 of instruction list
Number range	positive: 24 digits negative: 23 digits

Specimen of single-stage instruction (two words):

Op	V	L	X	A
A D D	M	3	2 3	1 0 0

ADD TO MEMORY: Memory address is "100" + (contents of index register 23).
Field length is 3 words.

Op, V, L, X are condensed by bit-wise coding into one word.
A forms the second word.

Specimen of single-stage instruction using a "literal"

Op	V	L	X	A
A D D			D	2 0 0

ADD TO ACCUMULATOR the digit-field "200".

Op	V		X/Y	A/B
L D	R		1 2	9 9 9
			1 5	0 0 6

LOAD six Index Registers, starting with R15; two words into each register.

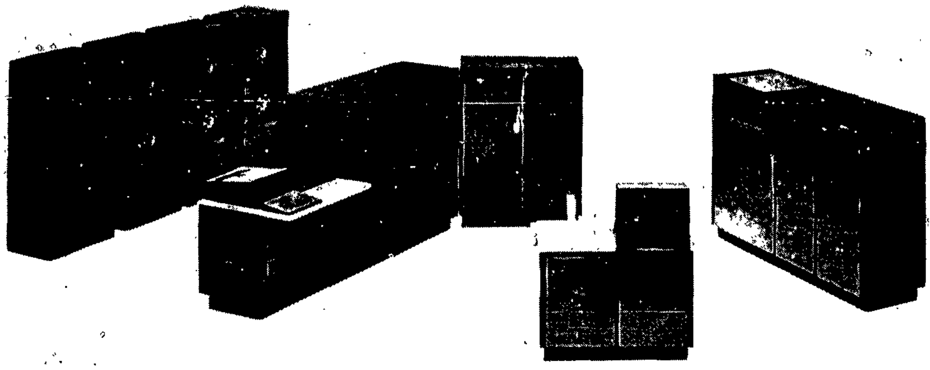


Photo by the National Cash Register Company

R15 loaded from memory address "999" + (contents of R12).
R16 loaded from memory address "1001" + (contents of R12).
--etc--

Op, V, X, Y are condensed by bit-wise coding into first and third words.
A forms the second word.
B forms the third word.

Specimen of double-stage instruction using a "literal"

Op	V		X/Y	A/B
S L D	R		D	0 0 0
			1 0	0 2 0

SPREAD-LOAD 20 Index Registers, starting with R10

Load zeros into every register from R10 through R29.

Automatic built-in subroutines include Scan, Move, etc. Load, Spread-load, Store, Move, Augment, Spread-augment: multiple registers.

Automatic coding using COBOL will be available for use with delivery of the first system. In addition, an intermediate language - NEAT assembler-compiler - is available for direct coding, and for optimization of object program after COBOL translation.

Registers and B-boxes include 32 Index Registers of 5 digits each and 32 Jump Registers of 5 digits each. This includes automatic storage of 3 different link addresses. The Sequence Control Register (Instruction Counter) is completely addressible. Automatic input-output tallies are used.

The entire system capable of any degree of polysynchronous operation, wherein any designated collection of peripheral units may each Demand program attention whenever appropriate. Demand interrupt is subject to a simple, flexible system of priorities, and to master control which may forbid interrupt altogether whenever desired.

Automatic program-tracing facilities for code checking are included.

Paper Tape and Punched Card input share all time except actual transmission of each character. Paper Tape, Punched Card and Printer output do the same.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	42	36
Mult	294 minimum	
Div	1,044 minimum	

Arithmetic mode   3 digits parallel
Timing   Asynchronous
Operation   Concurrent and Polysynchronous
Peripheral units operate asynchronously with processor

STORAGE

Media	No. of Words	No. of Digits	Microsec
Magnetic Cores	2,000 to 40,000	6,000 to 120,000	6 per word

Magnetic Tape

No. of units that can be connected	8 Units
No. of chars/linear inch	200,333 & 500 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	3/4 Inch
Tape speed	120 Inches/sec
Transfer rate	24K, 40K, 60K Chars/sec
Start time	3 Millisec
Stop time	3 Millisec
Average time for experienced operator to change reel	20 Seconds
Physical properties of tape	
Width	1/2 Inch
Length of reel	3,600 Feet
Composition	mylar, 1 mil, laminated

INPUT

Media	Speed
Paper Tape	1,000 char/sec

Any codes whatever, without limit. Inter-character time is sharable.

Punched Cards	400 cards/min

Any possible codes, including binary. Inter-character and inter-card time is sharable, with Demand Interrupt

Magnetic Character Reader	750 documents/min

Polysynchronous, with Demand Interrupt

Buffered Inquiry Units	333 KC alphanumeric

Each Inquiry Unit may be multiplexed to many remote Inquiry Stations, limited only by acceptable queueing. Polysynchronous.

OUTPUT

Media	Speed
Line Printer	600 lines/min alphanumeric 900 lines/min numeric

Buffered, sharable, with Demand Interrupt ability.

Paper Tape Punch	120 chars/sec

Any code whatever. Inter-character time sharable.

Card Punch	100 or 250 cards/min

Same as Printer

Buffered Inquiry Units	333 KC alphanumeric

Same as for input.

Line Printer has Multiple Listing Feature to enable simultaneous printing of three separate listings, each with independent paper transport. An interconnecting device is available to permit push-button switching of peripherals from one 315 Peocessor to another, in multi-processor installations.

CHECKING FEATURES

Checking features include complete parity-checking throughout the entire system.

PRODUCTION RECORD

Number produced to date	1
Anticipated production rates	7 per month initially

COST, PRICE AND RENTAL RATES

PRICE LIST

		Price	Monthly Rental
315-1	Basic Processor	$82,500	$1,300
315-2	Bank Processor	90,000	1,400
315-3	File Processor	90,000	1,400
315-4	Bank File Processor	95,000	1,500
316-1	2,000 Word Memory	37,500	650
316-2	5,000 Word Memory	55,000	1,100
316-3	10,000 Word Memory	75,000	1,600
332-202	40 kc Magnetic Tape Unit	27,500	700
332-203	60 kc Magnetic Tape Unit	36,000	900
340-3	High Speed Printer with 357-1 Buffer	72,500	1,425
354-1	Card Punch Buffer	25,000	450
355-1	Sorter Buffer	23,500	450
362-371	Paper Tape Reader and Punch	15,000	450
383-1	Punched Card Reader	20,000	450

PERSONNEL REQUIREMENTS

Training made available by manufacturer to users include a complete schedule of courses in programming, systems analysis, autocoding, COBOL, etc. All courses are available on the customer's premises.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a wide range of capacity and price with modular components, giving wide provision for future expansion and the Demand Interrupt feature so that under permissive program control peripheral units may interrupt, be reactivated, and continue their operation independently while the Processor returns to the primary program. This processor is unusually economical of memory space for program storage.

In multi-processor installations, all processors are the same with only one coding system. Work may be divided among processors at convenience of user, and each provides on-site backup for the other. Peripheral units may be electronically switched from one processor to another.

Normal procedures for magnetic tape handling are recommended.

FUTURE PLANS

Future plans include one and two degrees of magnetic tape simultaneity, a new concept of random access memory - magnetic cards, optional high-speed inputs, including paper tape at 1800 char/sec and punched cards at 2000 cards/min, and inter-communication, with master-slave relationship among multiple processors.

NATIONAL 390

National Cash Register Company Model 390 Computer

MANUFACTURER

National Cash Register Company

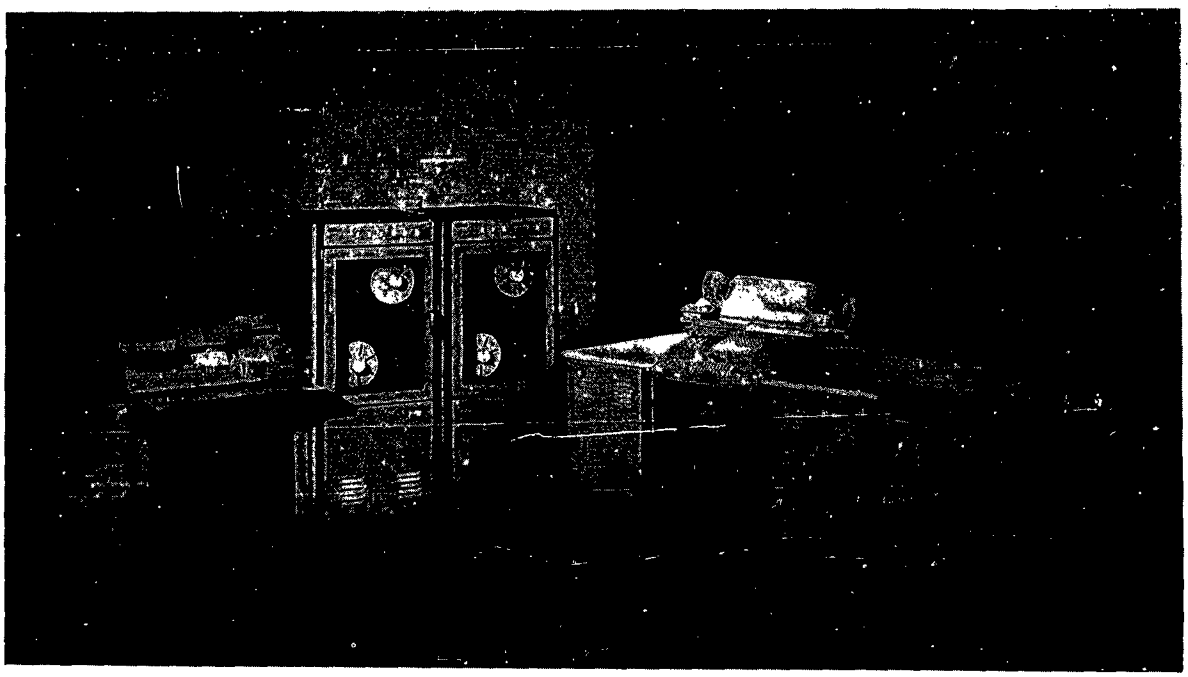


Photo by National Cash Register Company

APPLICATIONS

System is designed to handle all types of accounting records, reports, and statistics, paper tape sorting (Direct and Sequential), engineering calculations, and linear programming problems (Limited to 10 x 15 matrix or less).

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Decimal digits/word	12
Decimal digits/instruction	12
Instructions per word	1
Instructions decoded	27
Arithmetic system	Fixed point
Instruction type	Four address
Number range	From -1×10^9 to $+9 \times 10^9$

Instruction word format

Instruction*	Mode	Address A Operand	Address B Operand	Address C Modification	Address D Next Instruction

* Two decimal digits each

Automatic built-in subroutines include block transfer, and sum and add pairs of numbers. Variable block instructions perform some functions similar to B-boxes.

ARITHMETIC UNIT

Operation Time	Incl Stor Access Microsec
Add	11,000
Mult	250,000
Div	400,000

Above times are "worst case". Because of the 4 address system, command times all include access and storage.

Arithmetic unit is constructed of 48 cores, with transformers and diodes.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access
Core	200	2400	22 microsec/bit
Magnetic Ledger Cards	200 digits	200	220 char/sec

Variable word length on magnetic cards

INPUT

Media	Speed
Paper Tape (Photoelectric)	400 char/sec
Punched Card (IBM 024 or 026)	18 char/sec
Magnetic Ledger Card	220 char/sec

Speed of reading and writing depends on card length. The average is 1.5 to 2.0 secs.

Console Keyboard (Standard)

The Magnetic Ledger Card is a standard ledger card with standard visible posted information on the front and strips of magnetic tape on the back capable of storing up to 200 digits of information pertaining to that account.

OUTPUT

Media	Speed
Paper Tape	17 char/sec
Punched Card	18 char/sec
Magnetic Ledger Cards	Same as input
Accounting Machine Printer	1200 char/min

The Accounting Machine type printer is completely programmable both horizontally and vertically. It will accommodate continuous forms, journals, cut forms, and ledger cards all simultaneously, if desired and has all accounting machine checking, comparing, and accumulating features.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	4,000
Transistors	1,150
Magnetic Cores	9,792

14 vacuum glow triodes are used as indicators.

CHECKING FEATURES

Among the fixed checking features are a 5 bit parity check, reader and punch check, power supply tolerances auto check, a print-out check, and ledger card read-write failure indicators are used. Test points are available on all logical circuits.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

KVA, computer	4.8 KVA	1 phase	240v
Area, computer	78 sq ft		
Room size	10 ft x 15 ft		
Floor loading	20 lbs/sq ft		
	40 lbs concen max		
Weight, computer	1,000 lbs		
	1,500 lbs, total		

PRODUCTION RECORD

Number produced to date	6
Number in current operation	6
Number on order	100+
Anticipated production rates	600 - 700 annually

Quantity production will commence in the first quarter of 1961.

COST, PRICE AND RENTAL RATES

Basic System	Price	Monthly Rental
390-3 Console and Central Processor	$56,300	$1,395
361-1 Paper Tape Reader	10,000	250
461-2 Tape Recorder	1,735	50
Additional Equipment		
381-1 Punch Card Reader Coupler	$ 2,250	$ 60
468-1 Punch Card Coupler	815	27
417 Paper Tape Rewinder-Splicer	1,215	30
361-2 Paper Tape Reader		

Maintenance service is included in the rental price, or is approximately 5 to 6% of purchase price annually.

PERSONNEL REQUIREMENTS

A typical installation will require a combination supervisor and programmer, an operator, and possibly one clerk. The number of input operators would depend on the volume and type of input media and the method of creating it, e.g. by-product of necessary parent machine operation, off-line separate operation, etc.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Acceptance test specifies 40 hours continuous operation without failure or error. Tests are run under extreme marginal conditions.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include magnetic ledger cards, accounting machine printer, 4 address system, internally stored program, decimal coding, and desk size. The unique Magnetic Ledger Card which combines visible, auditable, historical information posted on the front, with machine language encoded on the back. Up to 200 characters of information pertaining to each account can be stored on the back of each card. The magnetic ledger philosophy provides unlimited external storage facility and immediate random access to a complete, up-to-date historical record.

FUTURE PLANS

Future plans include alphanumerics, a document sorter (MICR) input, optical document and journal readers, automatic ledger handling, increased speed and capacity, and a high speed printer.

NORC

Naval Ordnance Research Calculator

MANUFACTURER

International Business Machines Corporation

Photo by U. S. Naval Weapons Laboratory

APPLICATIONS

General scientific calculation in ordnance research, development and testing. Primary effort has been devoted to scientific computation, including satellite surveillance data reduction, orbital computation, missile ballistics, reactor design, war game simulation. A small portion of the time is spent on business type data reduction and computation.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	16
Decimal digits/instruction	16
Instructions per word	1
Instructions decoded	80
Instructions used	80
Arithmetic system	Floating or fixed point
Instruction type	Three address
Number range	10^{-43} to 10^{+31}

A number may be written as

$\pm$ x.xxxx xxxx xxxx · 10^{xx}

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	15
Mult	31
Div	227

Construction	Vacuum tubes and diodes (switching)
Rapid access word registers	2,000
Basic pulse repetition rate	1 Mc/sec

Photo by U. S. Naval Weapons Laboratory

Arithmetic mode	Serial
Timing	Asynchronous
Operation	Concurrent

Multiplication and division are partly performed in parallel. Operation time depends on decimal indices.

STORAGE

Media	No. of Words	No. of Digits (decimal)	Access Microsec
Magnetic Core	20,000	16 per word	8
Magnetic Tape	40,000,000		Variable

The core memory was built by Daystrom Instrument Corp. and installed in March 1960. Original memory was a 2,000 word Williams CRT System with same word size and access time. The magnetic tape system can read or search forward and backward and write forward.

INPUT

Media	Speed
Magnetic Tape (8)	70,000 dec dig/sec
Keyboard	Manual (Serial)

Eight tape units are in service. The packing density on magnetic tape is 500 char/inch, the linear speed is 140 inches/sec. 0.5 inch tape is used.

OUTPUT

Media	Speed
Magnetic Tape (8)	70,000 dec dig/sec
Mechanical Printers (2)	150 lines/min 407 mechanisms
CRT-Microfilm Printer and Plotter	15,000 char/sec

Built by Strombery Carlson; uses Charactron CRT; installed in 1958.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	9,800
Tube types	20
Crystal diodes	30,000
Separate cabinets	6

CHECKING FEATURES

Fixed checks include:
Bit count modulo-4 check on each word transfer
Modulo-9 arithmetic check
Illegitimate character check
Word-length and block-length check on tape reading.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	138 Kw	145 KVA	0.95 pf
Power, air condit	70 Kw	100 KVA	0.70 pf

Above figures are estimated.

Area in existing concrete building was remodeled. Special 12" raised floor used to cover air ducts and cable raceway. 40 ton closed circuit air conditioner used for main racks. 25 ton system used for auxiliary equipment and room cooling. Main computer room approximately 2,000 sq ft, power supply 500 sq ft, air conditioner 700 sq ft and shops 700 sq ft.

PRODUCTION RECORD

Produced	1
Operating	1

COST, PRICE AND RENTAL RATES

$2,500,000 is the cost of the machine as above described (without core memory and CRT printer) plus Card-Tape-Card Converter.

Additional costs were the Core Memory at $500,000 and the CRT Printer at $200,000. Total for the system is $3,200,000.

FUTURE PLANS

The IBM 7090 System and the IBM 1401 System will supplement the computer capability of the Naval Weapons Laboratory.

INSTALLATIONS

U. S. Naval Weapons Laboratory
Dahlgren, Virginia

PERSONNEL REQUIREMENTS

	7 Day/Week Three 8-Hour Shifts/Day
Supervisors	1
Analysts, Programmers, Coders	40
Clerks	4
Operators	13
Engineers	2
Technicians	10
In-Output Oper	12

Operation tends toward closed shop.

Methods of training used includes primarily on the job training, except that for the 7090 System to be installed, advantage is being taken of available instruction from IBM.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	1.2 Hours
Good time	133 Hours/Week (Average)
Attempted to run time	144 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.925

Above figures based on period 1 Jan 60 to 30 Jun 60
Passed Customer Acceptance Test June 1955
Time is available for rent to qualified outside organizations.

Time, when available, is used by Defense contractors as well as government agencies.

This machine is exceptionally well checked, both internally and with regard to input-output. Most errors can be corrected immediately by the machine operator with practically no lost time. Since installation of core memory, error free period is close to 2 hours.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include long word length, high arithmetic speeds, high tape speeds, checking features, CRT printer, three address logic, and ease of programming.

Magnetic tape stored in computer room in metal cabinets. Since the tape is not compatible with other units there is no reason for it to leave the completely controlled climate of this area. Acetate base tape is used.

Speed increased by taking short cuts in case of zero operands and through the use of previous result as an operand. Provisions for addition, subtraction, and shifting of instruction words make possible programmed synthesis of instructions. A large variety of conditional program transfer instructions are available. Three address-modifier registers make possible the modification of operand addresses without changing the stored instruction. Card-tape-card conversion is used.

NORDEN VOTE TALLY

MANUFACTURER

Norden Electronic Vote Tallying System Model 2602

United Aircraft Corporation
Norden Division
Data Systems Department

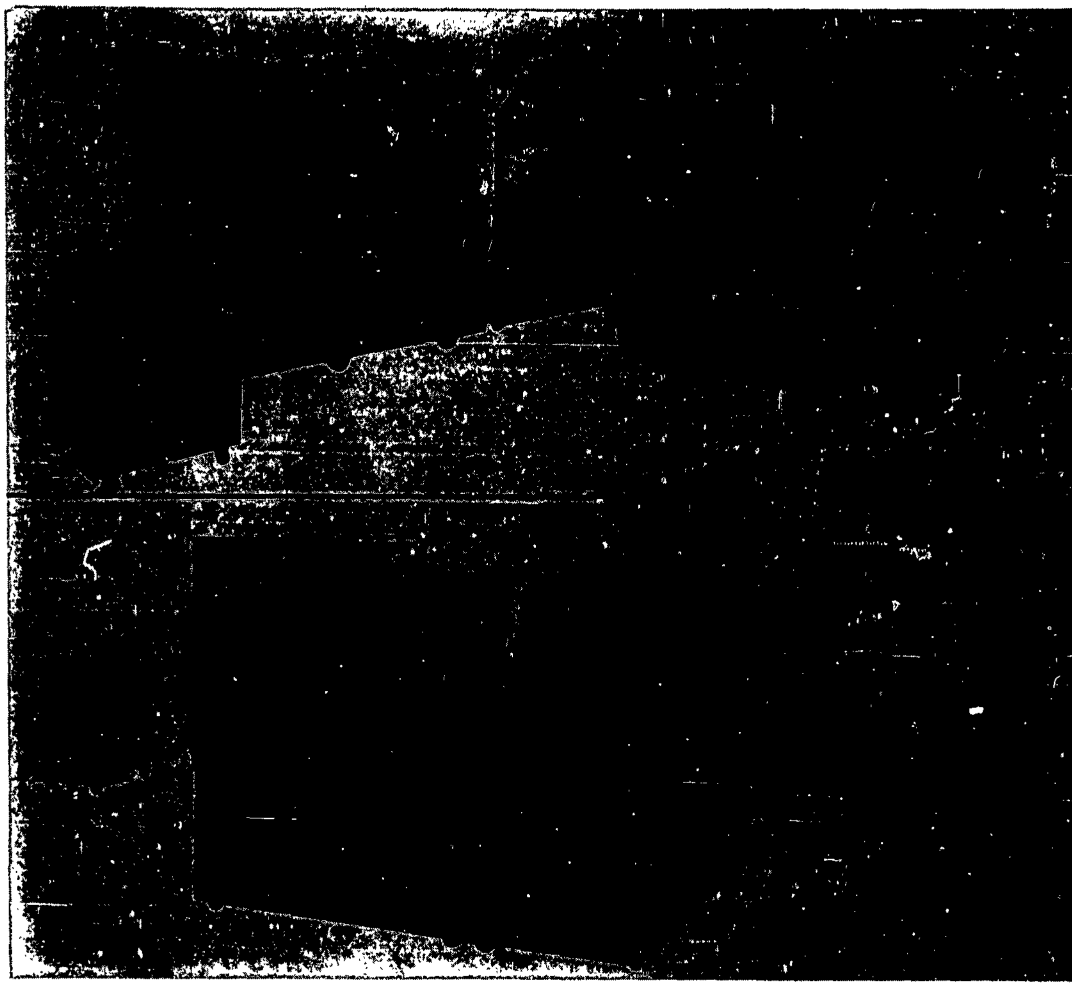


Photo by Norden Division, United Aircraft Corp.

APPLICATIONS

The Norden Vote Tallying System is a special purpose electronic system used to tally paper ballots at high speed. Votes are accumulated by candidate and issue in a magnetic core memory, and totals are output to a printer-punch unit. A short length of punched paper tape is used to instruct the processor as to the ballot width, color and format before ballots are read. This same tape establishes the punch-out sequence. Two mechanical paper handlers are attached to a processor. A ballot handler feeds ballots in a fixed length of 24" and varying from 9" to 30" in width at 10 ballots per second. Up to six ballot widths may be individually selected by paper tape instruction without manual intervention.

The ballots are not mechanically registered. The processor contains the necessary skew interpolation circuitry to compensate for a misaligned ballot. This circuitry is shared by the two ballot handlers. Only one ballot handler feeds ballots at a time. While one ballot handler is feeding and totals are being accumulated, the second ballot handler is being reloaded with a spindled tray of ballots and totals are being transmitted for the stack of ballots previously read. The alternate use of the ballot handlers permits the continuous processing of ballots. Each ballot is examined for acceptability in accordance with the Election Code to accept only valid votes. Overvoted offices and incorrectly voted recall issues or recall candidates are not accepted,

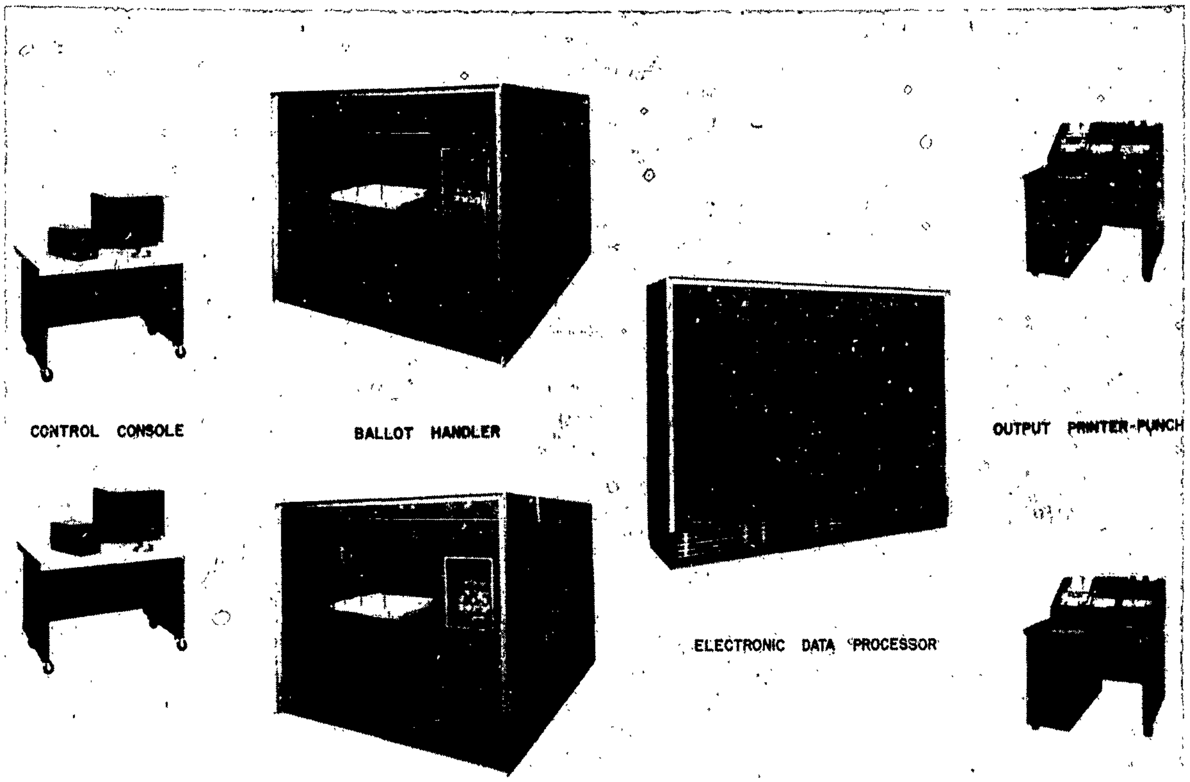


Photo by Norden Division, United Aircraft Corp.

but all valid votes are accepted to update totals. This analysis and updating occurs prior to the reading of the next ballot.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary and Binary Coded Decimal
Digits per word	3 decimal, 4 binary, 1 parity
Digits/instruction	one alpha per instruction
Instructions decoded	14 instructions
Arithmetic system	Fixed point

Each operation is defined by an alpha instruction character.

Number range 000 to 999 for each of 540 totals

One alphabetic character defines an instruction operation. For example, one character, followed by appropriate designators, instructs system on specific locations of voting squares on the ballots to be read. Another alphabetic character initiates the actual reading of ballots. Instructions are read from punched paper tape and are executed in sequence as read from the tape.

Essentially all operations in the system are built-in subroutines. These include updating of the totals in memory as each ballot is read, checks on over-voting, punch-out of candidate totals, etc.

All programming is in direct instructions.

Registers include instruction register, memory in-out register, ballot mark input registers, and punch encode register.

ARITHMETIC UNIT

Add time is 33 microseconds, including storage access, 6.6 for the actual add operation only. Arithmetic operation of updating totals after reading each ballot is an automatic subroutine.

Timing	Synchronous, within data processor
Operation	Sequential
Arithmetic mode	Serial

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core Memory	600	17 bits	3 to 4

INPUT

Media	Speed
Punched Paper Tape	60 char/sec
8-channel tape	
(7 information plus parity)	
Paper Ballots	10 ballots/sec

Ballots can be up to 30" wide, 24" long.

OUTPUT

Medium	Speed
Cards (80-Column)	18 columns/sec

System uses IBM 526 Printer-Punch

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
5651	2
6199	20
Diodes	
DR-385	Approximately 3,500
1N770	Approximately 1,000
Miscl.	Approximately 200
Transistors	
2N426	Approximately 3,000
2N388	Approximately 600
Miscl.	Approximately 300
Magnetic Cores	10,800 in each of two memories

Voltage regulator tubes used as reference tubes in power supplies.

Photomultiplier tubes in optical reading heads.

Follow-on systems will use 1N770 diodes.

Each memory has 18 core planes (one spare), with 10 columns, 60 rows in each.

Cores are General Ceramics.

Data is for Model 2602 Two-handler system.

CHECKING FEATURES

Checking features include paper tape parity, column read, ballot jam, memory parity, format pickup, precinct number agreement, power supply monitoring, double-punch and blank-column detection, and ballot clock-track check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	4.5 to 5	0.90 pf

Power includes tape reader and output card punch.

One system, employing two ballot handlers, requires approximately 1,200 sq ft of floor area. Total installation load for system is approximately 15,000 pounds. Data processor weighs approximately 2,000 pounds; each ballot handler, about 5,200 pounds. Operator consoles and output printer-punches account for remainder. Floor should be capable of supporting distributed load of 300 pounds/square foot. Site preparation requirements for each system include air compressor, an air fan to provide high-volume low-vacuum air, and a vacuum pump for high-vacuum pressure.

Ballot handlers operate alternately in reading ballots. While reading, drive motors in ballot handler draw approximately 20 KVA from 220-Volt 3 phase line. Air compressor, low-vacuum fan, and high-vacuum pump, required for each system, draw about another 20 KVA per full system from 220-Volt 3 phase line.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	12 months

Production of additional systems to be started soon for use in elections of 1962 and 1964.

COST, PRICE AND RENTAL RATES

Model 2602 System (2 Model 610 Ballot Handlers, 2 Model 620 Control Consoles, 1 Model 640 Data Processor cost approximately $600,000.

A slightly smaller system, Model 2601 System (1 Model 610 Ballot Handler, 1 Model 620 Control Console, 1 Model 630 Data Processor), cost approximately $375,000.

Maintenance contract, issued on annual basis, will be available from the manufacturer.

PERSONNEL REQUIREMENTS

Training made available by the manufacturer to the user include programming and operator training.

Typical election requires two console operators, and requires three ballot personnel per ballot handler. Total of 8 people per system per shift, plus one supervisor for the entire facility (which may be multiple-system facility).

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System employs solid-state construction throughout to attain reliability, and employs modular assembly techniques to facilitate rapid isolation and replacement of malfunctioning module. Indicator lights on each control console provide information on status of each component unit of system.

ADDITIONAL FEATURES AND REMARKS

System reads voter-marked ballots at rate of 10 ballots per second, and tallies ballots in accordance with election codes. Checks for over-voting, and provides for candidate rotation on ballots. Output totals are punched into cards; no manual transcriptions of totals from counters is required. System eliminates long hours of manual tallying of ballots at individual precincts. Handles variety of sizes of ballots. Output cards can be processed by conventional card equipment.

INSTALLATIONS

Los Angeles County, California

NUMERICORD

Numericord Machine Tool Director

MANUFACTURER

Concord Control, Incorporated

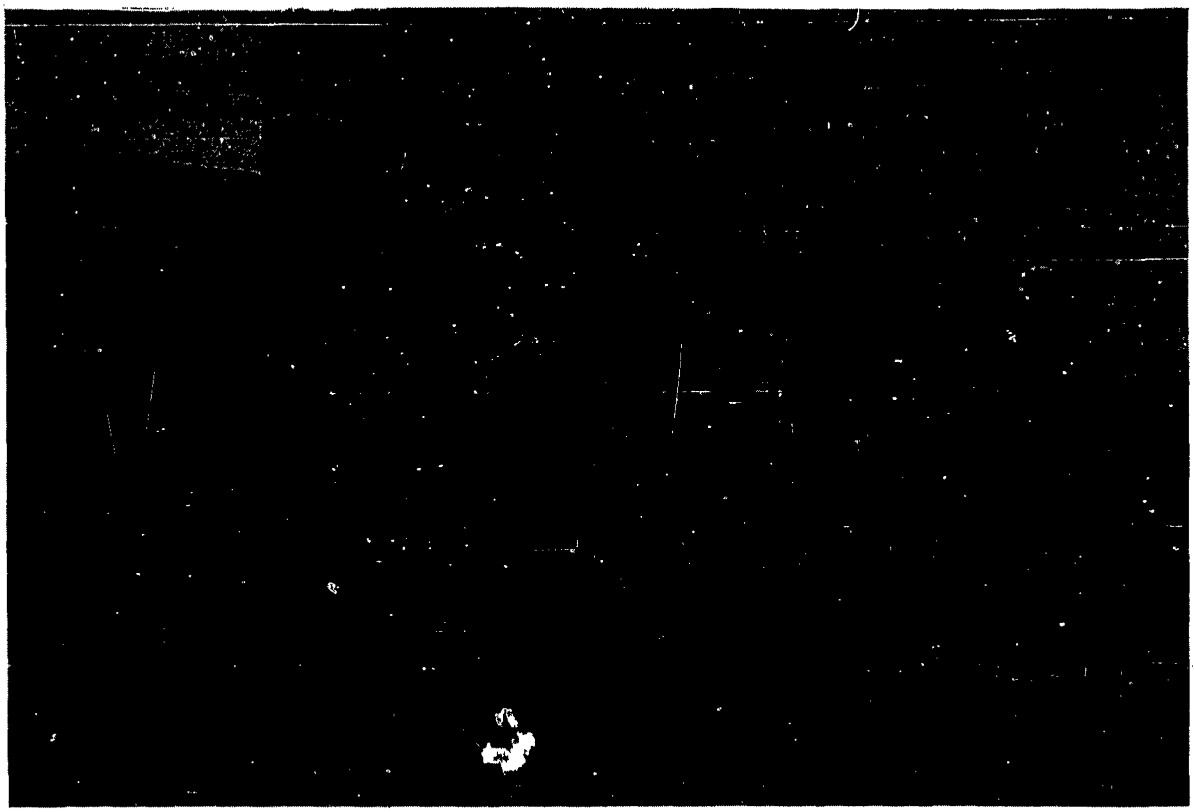


Photo by Concord Control, Incorporated

APPLICATIONS

The Numericord Director System is the Giddings & Lewis Machine Tool Company's numerical, continuous-path control system for automatically and electronically controlling a wide variety of multi-axis machine tools. Numericord is the registered trademark of the Giddings & Lewis Machine Tool Company, Fond du Lac, Wisconsin.

PROGRAMMING AND NUMERTCAL SYSTEM

Internal number system	Binary Coded Decimal
Decimal digits/instruction	43
Arithmetic system	Fixed point
Timing	Synchronous
Operation	Sequential

The Numericord Director System utilizes a fixed word length; instruction format and program for all computations.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core Memory	44	334	10

INPUT

Medium	Speed
Paper Tape	600 lines/sec

Utilizes high speed photo-electric one inch wide tape reader for input. Input system can also be modified to accept the magnetic tape output of a general purpose computer in lieu of the punched tape.

OUTPUT

Medium	Speed
Magnetic Tape	Continuous at 60 in/sec

Output information is continuous phase modulated quantized analog control signals on one inch, 14 channel magnetic tape. Magnetic tape output is used as permanent information storage medium between director system and machine tool. Director system can also be modified to control machine tool directly without magnetic tape storage.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	600
Diodes	5,000
Transistors	300
Magnetic Cores	300

CHECKING FEATURES

Fixed self-checking features indicate location of errors to one or more of approximately 12 system areas.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	6 Kw	9 KVA	0.66 pf
Volume, computer	250 cu ft		
Area, computer	45 sq ft		
Weight, computer	4,600 lbs		

No special site preparation required. System designed for operation in any normal office environment.

PRODUCTION RECORD

Number in current production 8 in United States

COST, PRICE AND RENTAL RATES

Director, Power Supply, and Tape Recorder cost approximately $225,000.

Tape preparation desk cost approximately $25,000.

System is normally not available for rental or lease.

Users maintenance personnel are fully trained at manufacturer's plant prior to system installation.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	Used	Recom	Used	Recom	Used	Recom
Operators	1	1	2	2	3	3
Technicians	1	1	2	2	3	3

Operation tends toward open shop.

Equipment operation is relatively simple. Initial personnel are trained on the job by manufacturer. Additional personnel can be quickly trained on the job as required.

The Numericord Director is a special purpose digital computer and although it is sometimes programmed manually, programs are normally prepared by a large general purpose computer. When used in this fashion the Numericord system can usefully be described as a piece of special purpose off-line peripheral equipment used in conjunction with a number of large general purpose computers.

Normal personnel requirements for the system usually consist of a trained operator and a trained electronic technician who is on call but not necessarily present at the equipment at all times. Programming is done by the regular data processing department mathematical programming section.

ADDITIONAL FEATURES AND REMARKS

Purpose - provides fully automatic control of complete work cycles for general-purpose machine tools having as many as five simultaneous axes of movement.

Operation - places all machine movements and auxiliary functions under control of a magnetic tape program which is prepared electronically from numerical data off part drawings.

Significance - provides a "store" of skills which makes workpiece accuracy a function of engineering and methods planning completely independent of machine operator's experience.

Application - while capable of automatically operating any type of machine tool, optimum effectiveness is achieved on multiple-axis, three-dimensional contouring machines.

Machine Scope - controls standard machine movements to generate such geometric shapes as straight lines, circles, ellipses and spirals or any shape that can be mathematically defined or arbitrarily set up in three-dimension coordinates.

Accuracy - tolerances obtainable with the Numericord System of machine control range from ± .0005" to ± .001" on the largest and most intricate workpiece. No cumulative error.

FUTURE PLANS

For several years this system has been used primarily by the aircraft and missile industries. Modifications and adaptations of the system are now being designed for special applications in precision plane and contour map making, coordinatography, precision plotting, flame cutting, X-ray inspection, and riveting.

INSTALLATIONS

Republic Aviation Corporation, Farmingdale,
Long Island, New York

Giddings & Lewis Machine Tool Company,
Fond du Lac, Wisconsin

Boeing Airplane Company
Wichita, Kansas

Convair, Division of General Dynamics
Fort Worth, Texas

Convair, Division of General Dynamics
San Diego, California

Lockheed Aircraft Corporation
Burbank, California

North American Aviation Inc.
Los Angeles, California

OARAC

Office of Air Research Automatic Computer

MANUFACTURER

General Electric Company

APPLICATIONS

Scientific computation and analysis.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	10 + sign
Decimal digits/instruction	7
Instructions/word	1
Instructions decoded	21
Instructions used	21
Arithmetic system	Variable fixed decimal point location, can be set to any of 11 digit positions initially. It must remain at this location during any given sequence of operations, in order to obtain consistent results.
Instruction type	Two address (The machine originally was a one address machine). The modification to a two address machine facilitated access to storage and permitted execution of special instructions with significant savings in time.
Number range	Variable $\pm (10^{10} - 1)$

Number system used is the 2*-4-2-1 system.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	400-17,000	91
Mult	10,000-26,000	800
Div	10,000-26,000	1,200

Construction

Vacuum tubes	400
Diodes	2,500

Basic pulse repetition rate	150 Kc/sec
Arithmetic mode	Serial by character Parallel by bits
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	10,000	110,000	1,000-17,000
Magnetic Tape	7,200 per 1,200 ft. tape		

INPUT

Media	Speed
Magnetic Tape	1,000 words/min
Keyboard	Manual

Keyboard is located on main control panel.

OUTPUT

Medium	Speed
Magnetic Tape	1,000 words/min

Contents of tape translated by an off-line code transcriber and typewriter.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	1,200
Tube types	12
Crystal diodes	7,000
Separate cabinets	2

Computer is housed in one cabinet and the magnetic drum is housed in another cabinet.

CHECKING FEATURES

Exceed capacity
Unprogrammed stop
Wrong combination
Synchronized tape
Divide by zero
Product exceed capacity
Tape runout, power and cooling failure fault checks.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	23 KVA
Volume, computer	600 cu ft
Area, computer	80 sq ft
Weight, computer	6,000 lbs
Capacity, air conditioner	10 Tons

The two cabinets measure 15 by 2.5 by 7 ft. and 4 by 5 by 6 ft.

PRODUCTION RECORD

Number produced 1

This system was developed on a research and development contract for the Air Force.

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $185,000.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	15 Hours
Good time	13,686 Hours
Attempted to run time	16,733 Hours
Operating ratio (Good/Attempted to run time)	0.82

Above figures based on period from Apr 53 to Apr 56
Passed Customer Acceptance Test Apr 53

ADDITIONAL FEATURES AND REMARKS

The OARAC has been improved. The improved version reportedly uses the same codes and commands as OARAC in order that problems may be run without difficulty.

The problem exists with most computer installations that a considerable amount of machine time is required for checking out problems and it is planned to compensate for this by using the new machine, which is faster than the old OARAC, for running checked-out problems only.

The new machine is supposed to have a 10,000 word core memory, and is supposed to be able to perform additions in 65 microseconds, excluding access time or in 130 microseconds, including access time and playback of the next instruction, multiply in 2.6 milliseconds and divide on an average of 6 milliseconds. This is supposed to result in an operating time savings of approximately 25 to 1 for most programs.

INSTALLATIONS

Aeronautical Research Laboratory
Wright Air Development Center
Wright-Patterson Air Force Base, Ohio

OKLAHOMA UNIV

Oklahoma University Computer 1066

MANUFACTURER

University of Oklahoma
Computer Laboratory

APPLICATIONS

Located in the Merrick Building, North Campus, University of Oklahoma, Norman, Oklahoma, the system is used for general purpose scientific and engineering computation.
This computer is a copy of the Rice University computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	54
Binary digits/instruction	54
Instructions per word	1
Instructions decoded	Approx. 2500 (Micro Programmed)
Arithmetic system	Floating point

Base 2^8; Exponent has sign plus 5 bits; Man., sign plus 47.

Instruction type	One address

With limited three-address options.

Number range Floating Pt: $2^{-295} \leq |n| < 2^{+248}$
Fixed Pt: $-1 < n < 1$

Instruction word format

6	15	6	4	8	15
4 Bit Address of One Operand; Sign Modification	Operation Field	Auxiliary Red-Tape Operation	15 Bit Address plus B Modifiers; Indirect Address Option; Sign Modification		

Automatic built-in subroutines
Provision for an entire class of these. Initially will have none. Tests for tags and certain arithmetic conditions are done automatically in the "Trapping Mode" of operation.
Automatic coding
ALGOL Compiler
Registers and B-boxes
7 rapid access 54-bit registers (4 listed also as fast access storage). 8 B-boxes - Instruction uses any combination and gives sum of contents as modifier. 1 fictitious "zero" register. 8 special purpose 15 bit registers.
Number of binary digits per word or instruction is 56 in memory, 2 of which are tags which can be tested when bringing from memory.
About 2,500 combinations in the operation field alone, with room for expansion.
One operand is taken from any of the 16 standard registers; a result from the operation can be stored back into any of the 16 or a B-box can be modified as a final auxiliary operation.
Two of the B-boxes have special designations as Control Counter and Pathfinder; respectively these contain the address of the next instruction, and an address from a previous transfer.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	7 to 16	3 to 4
Mult	108	100
Div	108	100

Times are estimated.
Construction (Arithmetic unit only)

Vacuum-tubes	900
Transistors	60
Diodes	5,600
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Bin Dig/Word	Access Microsec
Flip-Flop Register	4	54	< 1
Electrostatic (CRT)	8,192 (present)	63	8(avg)
Diode-Capacitor	4	63	Buffers

Magnetic Tape

No. of units that can be connected	8 Units
No. of char/linear inch of tape	500 Char/inch
Channels or tracks on the tape	10 Tracks/tape
Tape speed	75 Inches/sec
Start time	7 Millisec
Stop time	10 Millisec
Physical properties of tape	
Width	0.75 Inches

The flip-flop registers are located in the arithmetic unit and listed there also. Barrier Grid type CRT is used. 63 bits include 54 word, 2 tags, 6 error correction code, and 1 parity. Diode-Capacitor registers are buffers to and from magnetic tapes.

INPUT

Media	Speed
Paper Tape	400 hexads/sec 44 words/sec
Ferranti T.R. 5	(Photoelectric)
Magnetic Tape	2 to 4 words/millisec
Typewriter	Manual (IBM Input-Output Writer)
Switches	Manual (Can set 4 Special-Purpose Registers)

Operator can type to or from any register.
Sense, Mode, Trapping, Indicator Registers.

OUTPUT

Media	Speed
Line Printer	20 lines/sec (numeric) 10 lines/sec (alphanumeric)
Paper Tape Punch	100 codes/sec 6 levels plus control
Typewriter	10 octal dig/sec
Magnetic Tape	

Printer mechanism is Anelex 56-160.
Punch is Teletype BRPE 11
Paper Tape preparation is by off-line Flexowriter.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type			
Tubes			
5965	About	1,500	
6197	About	300	
S11E12	About	20	A high quality British power pentode.
2D21	About	120	To drive printer hammer solenoids.
1858		63	Barrier-grid storage tube.
Total approx.		2,000	

Diodes
OMC-537
SG211
Other miscellaneous
About 16,000 total (estimate)
The majority of these are OMC-537 which is a Gold-Bonded Germanium Diode

Transistors
2N585
2N598
2N393
SB101
Others
Total 2,000 - 3,000 (estimate) mostly the first two types

Primary uses: instruction decoding and gates, peripheral equipment, and memory preamplifier.

Magnetic Cores 700 Used for pulse transformers

The above quanities include some rather gross estimates for the control unit which is only partially completed.

CHECKING FEATURES

Six bit error correction code plus parity on electrostatic storage and magnetic tape. Corrects singly-occurring bit failures. Exponent, mantissa overflow indicators which can be automatically checked as a trap condition.

Provision for marginal checking of circuits. Rounding is optional on results of certain arithmetic operations.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	12 Kw (estimated)
Capacity, air conditioner	15 Tons

PRODUCTION RECORD

Number produced to date	0
Number in current operation	Sections only, not entire system
Number in current production	1

System operation anticipated in 1961.

COST, PRICE AND RENTAL RATES

Locally produced.

ADDITIONAL FEATURES AND REMARKS

On any instruction the address can be modified by any combination of the 8 index registers (B registers), the control counter as a B register allows easy relative addressing of subroutines. Large exponent base for faster floating point operations, extra long mantissa to minize loss of significance by shifts of 8.

Provision for repeating the same instruction in a 1-word loop. Result of any arithmetic or logic can be returned to memory as a general "add-to-memory" with a block transfer option.

Interchange options allow integer arithmetic, where the fixed point number range can be considered as $\pm 2^{47}$.

Two tag bits in memory on either words or instructions.

A special register of "Mode Lights" allow special modes of machine operation: trapping mode where certain tests are made during the instruction execution; repeat mode for repeating the same instruction; rounding on multiplication and floating point addition and subtraction is optional by "Rounding Mode".

There is provision for using two magnetic tape units concurrent with normal program execution.

The designation 1066 refers to the Battle of Hastings, in as much as the computer is located at Norman.

This computer is a copy of the Rice University Computer, see that description for further comments that are applicable as of 1960-1961.

FUTURE PLANS

Memory size to be increased to full 32,000 word capacity after the system is running.

INSTALLATIONS

University of Oklahoma
Computer Laboratory
Merrick Building - North Campus
Norman, Oklahoma

ORACLE

Oak Ridge Automatic Computer and Logical Engine

MANUFACTURER

Oak Ridge National Laboratory
Argonne National Laboratory, Jointly

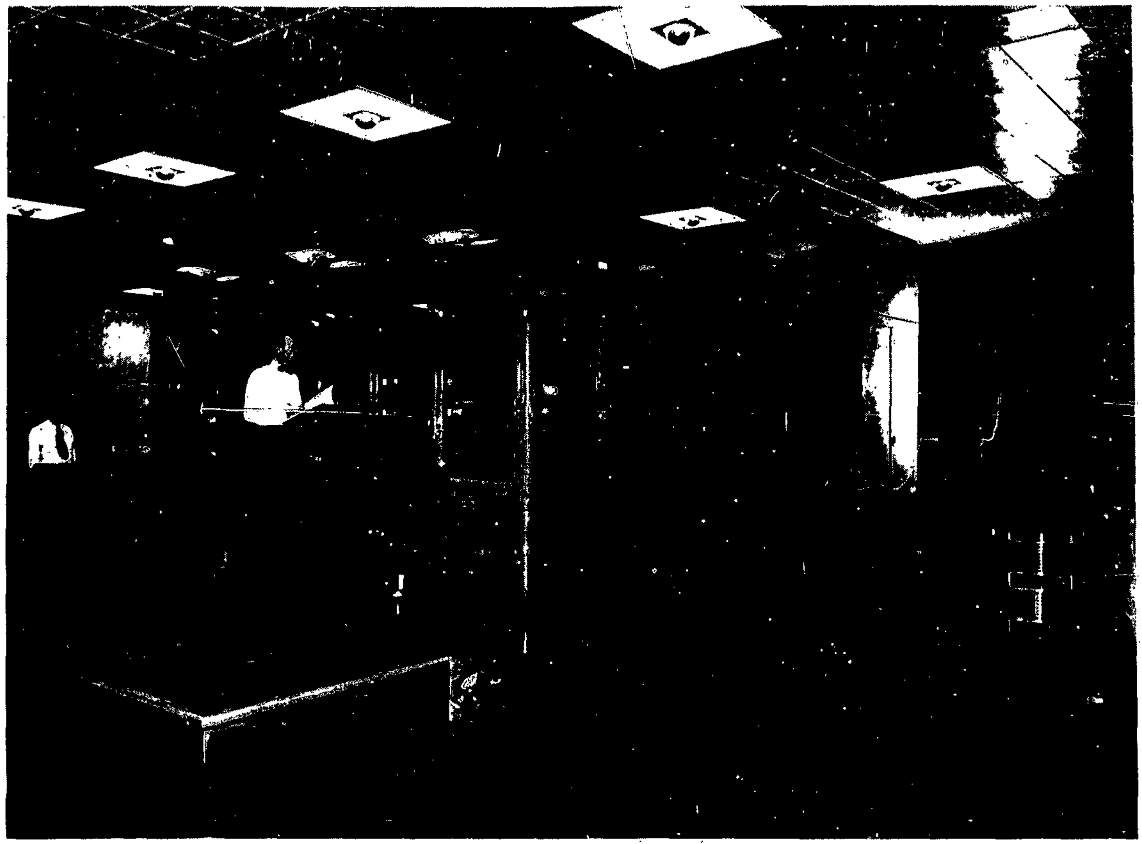


Photo by Oak Ridge National Laboratory

APPLICATIONS

Located at X-10 site at the Oak Ridge National Laboratory, use and application has been primarily as a research and development tool for numerical analysis, programming techniques, and problems in physics, chemistry, engineering and biology. Methods have been developed for solving linear equations, matrix inversions, computing eigenvalues and vectors of matrices, solution of reactor problems involving ordinary and partial differential equations. Monte Carlo techniques have been designed and applied to problems in health physics and shielding. Many "one of a kind" problems are solved which involve methods mentioned above as well as function evaluation, interpolation and statistical analysis. In the last few years much effort has gone into data processing, data handling and reduction. System is a large scale and general purpose computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	40
Binary digits/instruction	8
Instructions/word	2
Arithmetic system	Fixed point
Instruction type	One address
Number range	-1 to $+ (1 - 2^{-39})$

Instruction word format

Order	Break Point	Address
8	1	11

Registers
Accumulator, quotient and storage registers

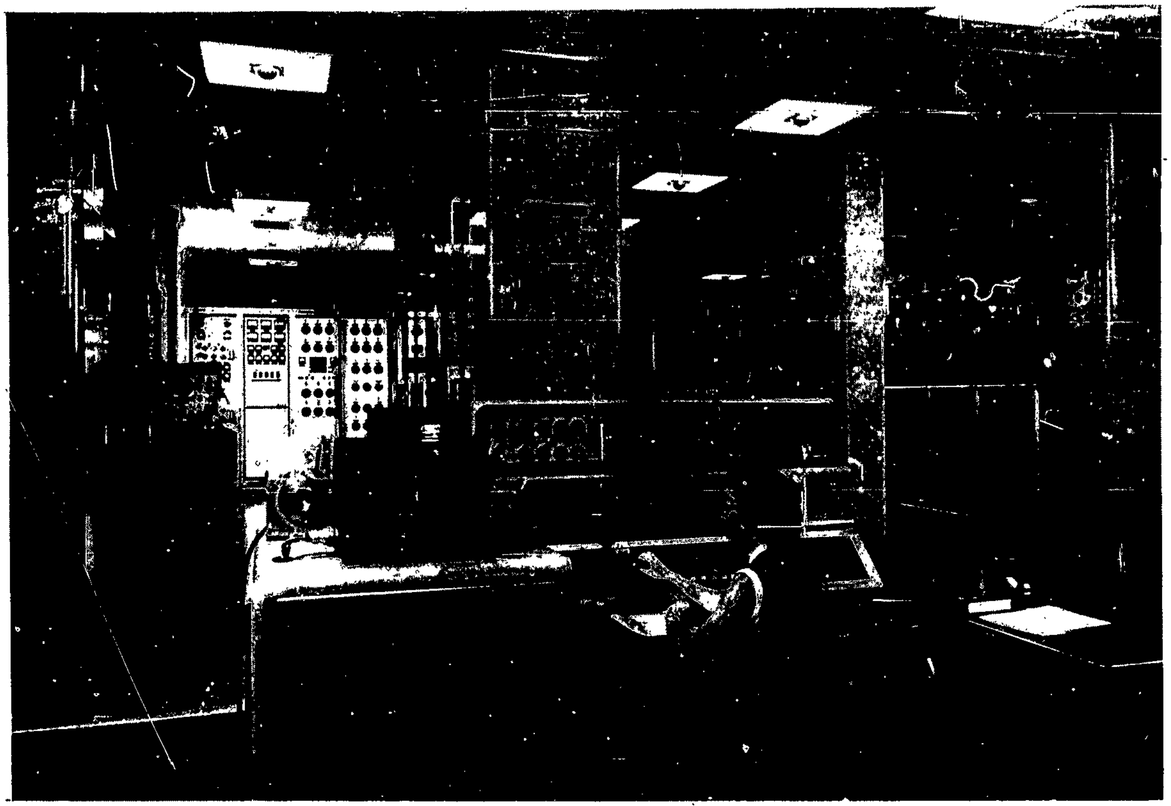


Photo by Oak Ridge National Laboratory

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	70	8
Mult	370-590	Slightly less
Div	590	Slightly less

Construction (Arithmetic unit only)
Arithmetic unit is constructed of vacuum tubes, transistors, and diodes. Type 2N43 transistors and type 1N68 and 1N191 diodes are used.

Arithmetic mode	Serial
Timing	Synchronous in storage and asynchronous in arithmetic
Operation	Sequential Concurrent in magnetic tape hunting operations

STORAGE

Media	No. of Words	Access Microseconds
Cathode Ray Tube	2,048	18
Magnetic Tape	3×10^6	50,000/block
Four handlers		128 words/block

No. of units that can be connected	4 Units
No. of chars/linear inch	170 Chars/inch
Channels or tracks on the tape	42 Tracks/tape
Blank tape separating each record	1 Inch
Tape Speed	47 Inches/sec
Transfer rate	8000 chars/sec
Start time	5 Millisec
Stop time	5 Millisec
Average time for experienced operator to change reel	30 seconds
Physical properties of tape	
Width	2 Inches
Length of reel	1,000 Feet
Composition	.003" Mylar base .001" Oxide coating

INPUT

Medium	Speed
Paper Tape (Ferranti)	200 char/sec

OUTPUT

Media	Speed
Photographic Curve Plotter	2000 char/sec

Used for point plotting also
Characters are series of points

Console Typewriter	10 char/sec

Not normally used for output

Paper Tape	60 char/sec
Teletype BRPE-2	
Magnetic Tape	1000 char/sec
Printed on typewriter at 10 char/sec	

Output magnetic tape is run at 60 in/sec on ORACLE and slowed to 0.6 in/sec for printing on typewriter (IBM).

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type		Quantity
Tubes		
5844		
5965		
7044		
6211		
3633		
6BC7		
6AL5		
6AK5		
6AH6		
12AT7		
12AU7		
12AX7		
	Total	5,000
Diodes		
1N68		
1N191		
	Total	200
Transistors		
2N43		100
Magnetic Cores		None

CHECKING FEATURES

Word parity on memory
Word parity on magnetic tape
Character parity on paper and magnetic tape

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	75 Kw	0.9pf
Room size	60 ft x 60 ft	
Capacity, air cond., computer	25 Tons	
Capacity, air cond., room	15 Tons	

A false floor consisting of four plenums covers 0.9 of room. Ducts under false floor and over roof seals in closed loop air conditioning. A separate 4400-volt power line transformer is used.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Arithmetic Unit		
Memory Unit		
Magnetic tape unit		
Input-Output and Console		
	Total	$250,000

PERSONNEL REQUIREMENTS

	Three 8-Hour Shifts Used	Recommended
Supervisors	2	
Analysts	4	8
Programmers	40	
Coders	2	8
Clerks	1	
Librarians	1	
Operators	5	
Engineers	1	3
Technicians	6	

Methods of training includes classes in basic coding and algebraic language coding.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running time	4 hours
Good time	3,869 hours
Attempted to run time	4,252 hours
Operating ratio (Good/Attempted to run)	0.91
Figures based on period	Jul 55 to Jul 56
Acceptance test	1 Sep 53

ADDITIONAL FEATURES AND REMARKS

Two operating modes are possible in the ORACLE.
Mode 1 is the 1024 word mode in which time multiplex is used between a pair of Williams tubes to determine the stored information for each bit. When either tube reads a dash signal, a dash is replenished to both. This method overcomes the common type of screen blemish which would prevent storage of a "1" (dot-dash).
Mode 2 is the 2048 word mode in which each tube stores 1024 bits. The first tube is regenerated in the first half of a major cycle and the second tube in the second half.
IAS type computer.

INSTALLATIONS

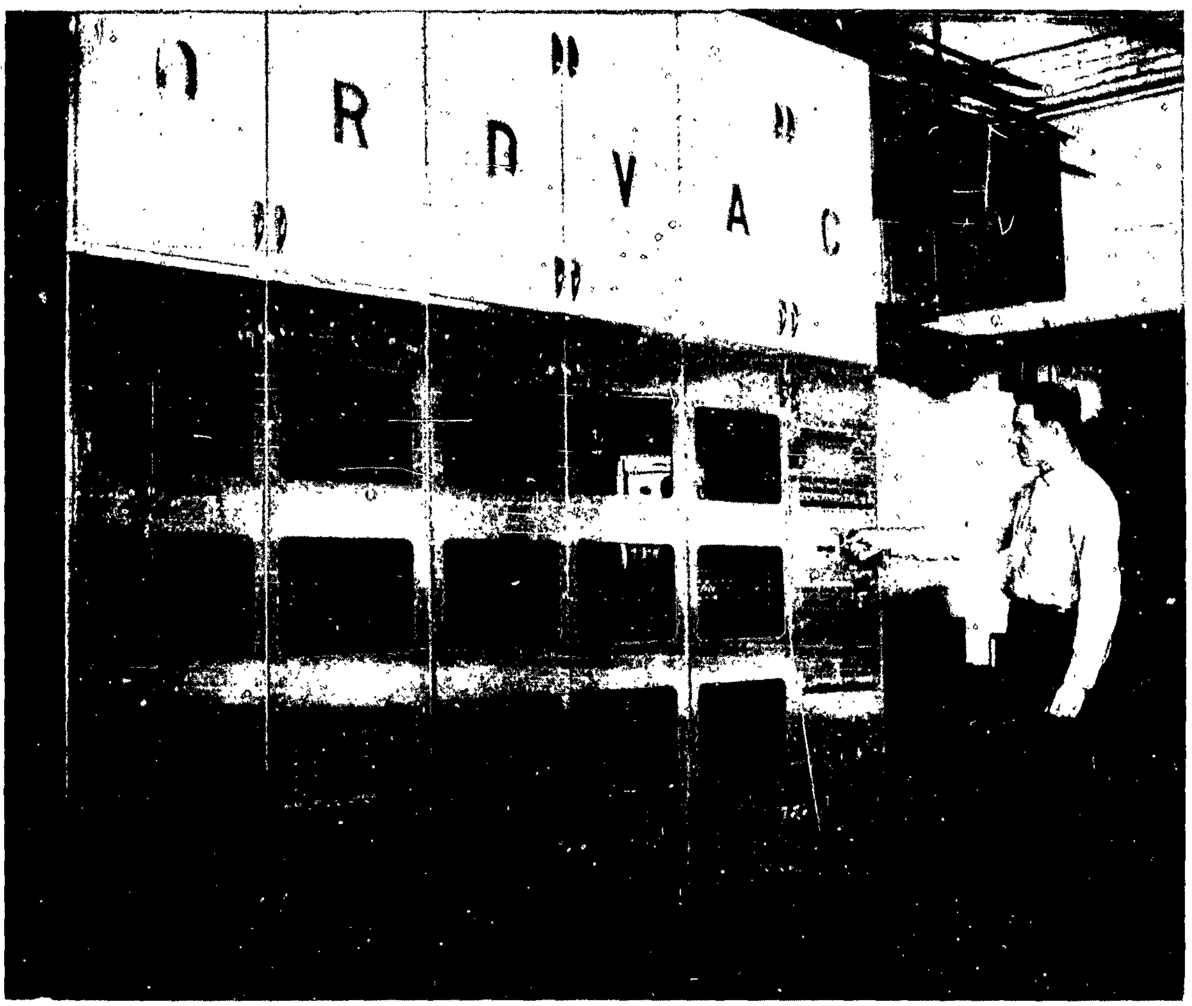
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee

ORDVAC

Ordnance Variable Automatic Computer

MANUFACTURER

University of Illinois



U. S. Army Photo

APPLICATIONS

Ballistic Research Laboratories

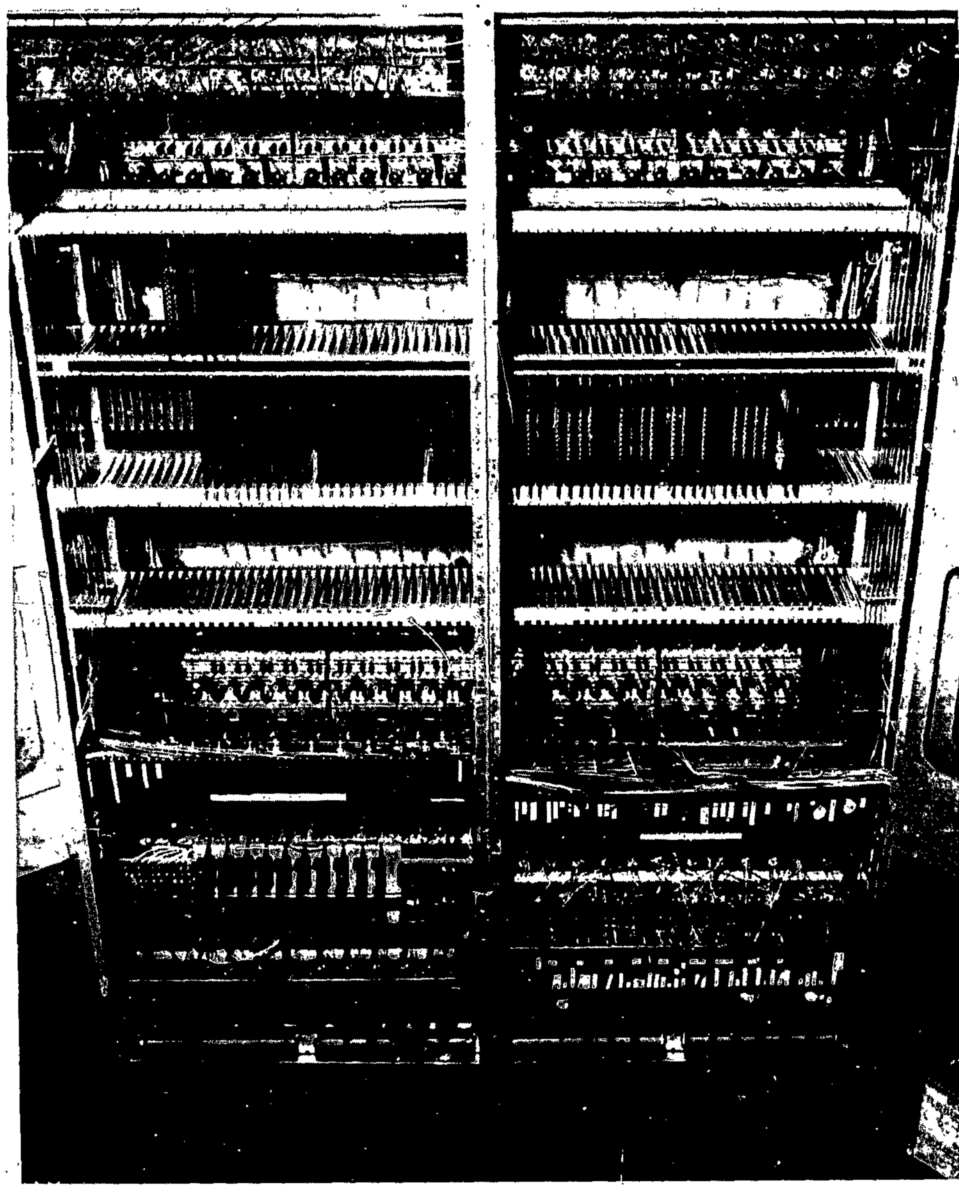
Exterior ballistics problems such as high altitudes, solar and lunar trajectories, computation for the preparation of firing tables and guidance control data for Ordnance weapons, including free flight and guided missiles.

Interior ballistic problems, including projectile, propellant and launcher behavior, e.g. physical characteristics of solid propellants, equilibrium composition and thermodynamic properties of rocket propellants, computation of detonation waves for reflected shock waves, vibration of gun barrels and the flow of fluids in porous media.

Terminal ballistic problems, including nuclear, fragmentation and penetration effects in such areas as explosion kinetics, shaped charge behavior, ignition, and heat transfer.

Ballistic measurement problems, including photogrammetric. ionospheric, and damping of satellite spin calculations, reduction of satellite doppler tracking data, and computation of satellite orbital elements.

Weapon systems evaluation problems, including anti-aircraft and anti-missile evaluation, war game problems, linear programming for solution of Army logistical problems, probabilities of mine detona-



Transistorized Arithmetic Unit

U. S. Army Photo

tions, and lethal area and kill probabilities of mine detonations, and lethal area and kill probability studies of missiles.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	40
Instructions per word	2
Instruction type	One Address
Binary digits in operation code	6 or 9
Binary digits in address	12 or 10
Instructions used	55 or 72
Arithmetic system	Fixed point
Number range	$-1 < x < 1$

Instruction word format

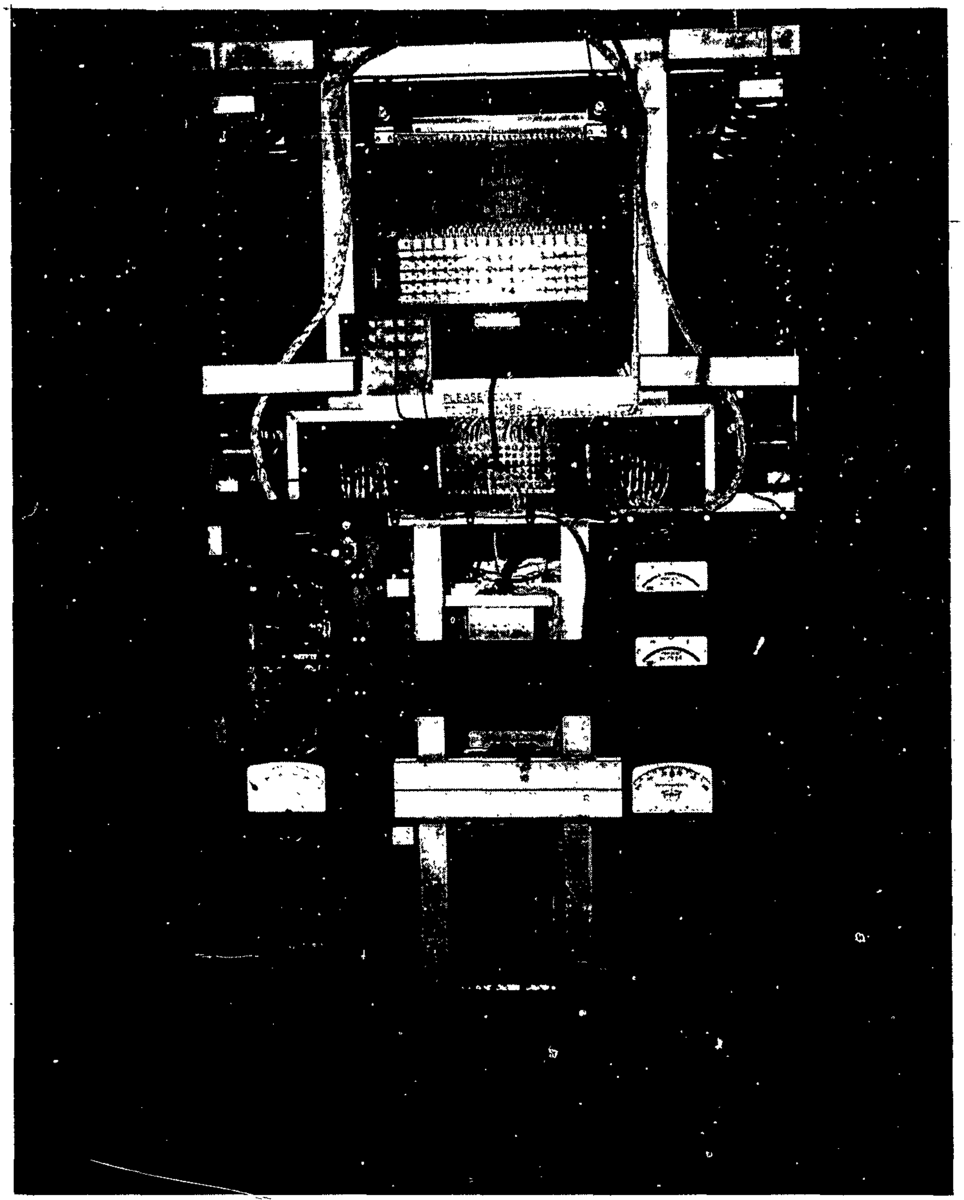
Left Instruction			Right Instruction		
6 Order	2 Unused*	12 Address	6 Order	2 Unused*	12 Address
20 Bits			20 Bits		

*One bit will be used to differentiate flc point numbers from fix point numbers

Rapid Access word registers - 3

Sexadecimal representation is used externally.

Negative numbers are handled as 2 complements.



Magnetic Core Memory

U. S. Army Photo

Floating point operation may be programmed.

Dual code - ORDVAC operates on a dual code basis. The codes are, on a two instructions per word basis, i.e. 20 digits per instruction:

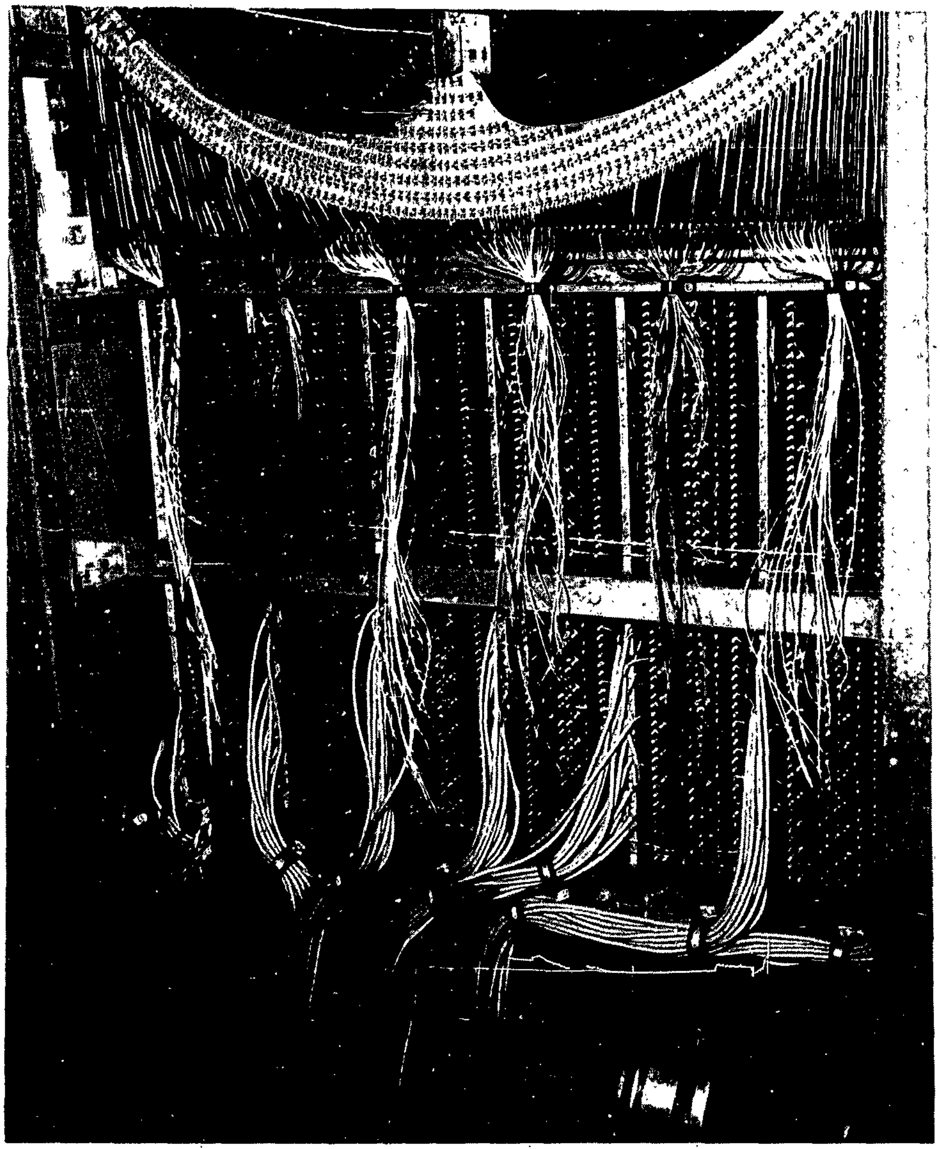
Code A - 1,024 words of storage:
- 9 digit, command
- 1 digit, spare
- 10 digit, address

Code B - 4,096 words of storage:
- 6 digit, command
- 2 digit, spare
- 12 digit, address

This system permits utilization of routines developed previous to the 4,096-word operation change over.

ARITHMETIC UNIT

Arithmetic mode	Parallel
Basic pulse rate	Not pulse controlled
Add time (Basic addition by arithmetic unit)	14 microsec
Multiply time (exclud. stor. access)	700 microsec
Divide time (exclud. stor. access)	700 microsec



Transistorized Channel Selector

U. S. Army Photo

The total add time, including transfer to final register, is 50 microseconds. None of the above figures include access to storage.
Construction, Arithmetic unit only - Transistorized on printed circuit plug-in boards, using 1,000 Type 2N128 transistors.

Timing	Asynchronous
Operation	Parallel

STORAGE

Media	Words	Digits	Access
Magnetic core	4,096	163,840 bits	15 microsec
Magnetic drum	10,032	401,280 bits	80,000 " /48 words

Magnetic drum purchased from ERA Division of Sperry Rand, Incorporated. The track selector for the magnetic drum has been transistorized. Magnetic core storage unit purchased from Telemeter Magnetics, Incorporated. Both above storage units adapted to ORDVAC and installed by Ballistic Research Laboratories personnel.

INPUT

Media	Speed
Teletype tape (5 hole)	2.5 words per sec
Punched cards	40 words per sec (bin)
	8 words per sec (dec)
Ferranti Hi-speed Paper Tape Reader	20 words per sec (bin)
Magnetic tape	300 words per sec

The special purpose one inch wide magnetic tape system for transferring telemetered data to ORDVAC has 6 information tracks and 3 control tracks.

OUTPUT

Media	Speed
Teletype page printer	0.4 words per sec
Teletype tape	0.4 words per sec
Punched cards	40 words per sec (bin)
	8 words per sec (dec)

Transistorized magnetic core contents display.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes

Type	Quan	Type	Quan
5964	817	C6J	28
5687	420	6X5	4
2C51	568	OC3	4
5965	637	6SF5	4
6AL5	47	6AC7	4
6A67	2	12SN7	12
2D21	160	12AU7	1
6080	21	6AH6	9
6AN5	13	6350	86
0B2	14	6829	2
7AK7	16	6216	2
5963	46	6BJ7	42
6AV6	13	6197	90
5R4	2	6293	193
6L6	26	5998	72
12AX7	22	6336	27
6X4	6	350B	4
5651	12	0A2	3
6AQ5	1	Total	3,430

Transistors

Type	Quan	Type	Quan
2N162	20	2N1056	250
2N140	65	2N113	75
2N128	1300	2N426	25
2N109	346	2N425	10
		Total	2,091

Diodes

Type	Quan	Type	Quan
1N91	418	1N63	15
1N93	162	1N58A	10
1N52	10	1N298	300
		Total	915

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power Consumption	
Computer	40 K.W.
Core Memory	15 K.W.
Magnetic Drum	6 K.W.
Air Conditioning	
Computer	15 Tons
Core Memory	7.5 Tons
Magnetic Drum	3 Tons
Space	
Computer	630 cu ft · 80 sq ft
Weight	
Computer	3,000 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Rental rates for additional equipment
$648.57 per month
The additional rented equipment is:

I.B.M. punch	$ 83.32 per month
I.B.M. reader	$ 82.50
I.B.M. reproducer	$122.50
I.B.M. tabulator	$360.25

Approximate cost of basic system $600,000.

PERSONNEL REQUIREMENTS

Typical Personnel

	Three 8-Hour Shifts
Supervisors	6
Analysts	3
Programmers and Coders	14
Clerks	1
Engineers	1
Technicians	6

No engineers are assigned to the operation of the machine, but are used for development and design of additions to the machine. The technicians consult the engineers when a total break-down occurs.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	Approx. 6 hours
Good-time	7,475 hours
Attempted to run time	8,760 hours/year
Operating ratio	0.85

The above figures are based on the yearly average of the last 5 years. Approximately 2 hours per week are used for scheduled preventive maintenance and 10 hours per week are used for running computer test programs. The 1,286 hours difference above were used for testing, servicing, bad operating time, general improvement, and the incorporation of new components.

ADDITIONAL FEATURES AND REMARKS

The ORDVAC belongs to the group of computers whose basic logic was developed by the Institute for Advanced Study and utilized in the IAS computer. This IAS family of computers is made up of such machines as the ILLIAC, ORACLE, AVIDAC, MANIAC, JOHNNIAC, MISTIC, and CYCLONE.

The ORDVAC is a direct-coupled machine using three-dimensional construction. A direct-coupled machine is one that connects the voltage level of one component directly to the input of the next, without voltage isolation between. This feature is very helpful in trouble-shooting the system. Three-dimensional construction is sometimes called low-capacitance wiring. In the ORDVAC, three-dimensional wiring is employed by placing the arithmetic unit and other controls on opposite sides, and interconnected wiring running across the open space between. The machine can be remotely controlled from commercial Teletype units.

ORDVAC is equipped with the option of two different instruction codes. Code -9 (nine bits per instruction) makes 1,024 words of high speed core storage available to the operator while Code -6 (six bits per instruction) makes 4,096 words of high speed storage available. Each code shares a common nine-bit decoder; however, when the code -6 option is used the instruction first passes through a code translator which translates the six bit instruction into its 9-bit equivalent. There is no loss of time while making the code translation.

The translator uses the following number of circuit elements

Transistors		
SB 100	135	
2N 43	24	
2N 140	12	
Total	171	
Crystal diodes		253
Resistors		305
Capacitors		23

The above components are mounted on 21 printed circuit boards. Power dissipation is approximately 5 watts.

INSTALLATIONS

Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland

FUTURE PLANS

The Floating Point unit for the ORDVAC will be fully transistorized, with a number range of 2^{127} to 2^{-128}, using a seven bit biased exponent. Numbers will be normalized automatically on transfer to storage. The mantissa of the normalized floating-point number will have a range of $1/2 > c > -1/2$. This system will require that an existing register be converted from a one-sided shifting register to a two-sided shifting register.

Fully transistorized control circuitry for new indexing orders will be added in the near future.

General purpose magnetic tape stations will be added to the ORDVAC shortly, with provisions for 8 stations. ORDVAC will control read, write, re-wind forward and backward, move tape forward and back N words, starting at A address of memory, transfer to B address of memory for next instruction, re-record N words, playback N words, check for parity error, transfer on error, and other functions.

Circuit Elements, Entire System

Magnetic Cores

Quan	OD	ID	Thick	
172,032	100	70	30	mils
5,376	375	260	125	mils

PACKARD BELL 250

Packard Bell Computer Model 250

MANUFACTURER

Packard Bell Computer Corporation

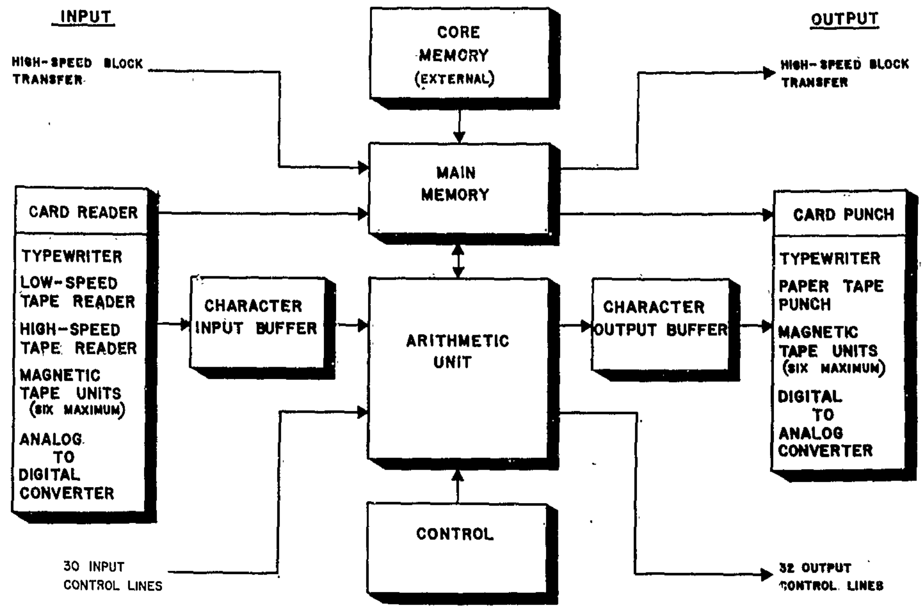
Photo by Packard Bell Computer Corporation

APPLICATIONS

The PB 250 is a high speed digital computer designed to be used for general purpose computing and as a system component for on-line, real-time, data handling.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	21 plus sign
Binary digits/instruction	22
Instructions per word	1
Instructions decoded	63
Arithmetic system	Fixed point
Floating point by subroutine	
Instruction type	One address (Modified)
Number range	6 decimal digits



Block Diagram by Packard Bell Computer Corporation

Instruction word format

22 15	14	13 8	7 3	2	1
Sector Number	Sec Tag	Op Code	Line Number		Index Tag

An index register may be loaded to modify line number of address. (The contents of the index register replaces line number of all instructions where a tag is specified.)

A single instruction can shift the memory location of a specified number of words by one address position thus eliminating the need for address modification while maintaining optimum programming.

Optimum programming is provided for by provision for relative addressing for next instruction.

Automatic built-in subroutines include square root and gray-to-binary conversion.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	108 Avg	12
Mult	372 Avg	276 (max)
Div	348 Avg	252 (max)

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential or non-sequential

The PB 250 operates at a clock frequency of 2 Mc giving a word time of 12 microsec. The arithmetic unit is completely serial in operation as is the magnetostrictive delay line memory. The serial approach provides low component count with low cost and high reliability. The 2 Mc clock provides microsecond speed formerly associated only with very large expensive machines. The magnetostrictive delay line memory can be expanded from the basic 1808 words in 1 to 256 word increments to 15,888 words by the simple addition of plug-in units.

STORAGE

Media	No. of Words	No. of Bits	Access Microsec
Magnetostrictive Delay Line	to 15,888	to 349,536	1,540 avg
Magnetic Core	to 16,384	to 360,448	

Magnetic Tape

No. of units that can be connected	6 Units
No. of chars/linear inch of tape	200 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	5, 10 Inches/sec
Transfer rate	1 or 2 Kc/sec
Start time	3 Millisec
Stop time	1.5 Millisec
Physical properties of tape	
Width	1/2 Inches
Length of reel	2500 Feet

INPUT

Media	Speed
Flexowriter	10 6 or 8 bit char/sec
Paper Tape	300 6 or 8 bit char/sec
Magnetic Tape	2,000 7 bit char/sec
Serial	2 Mc bit, 83.3 KC word rate

30 control inputs used with the transfer on external signal command are also available for control applications.

OPERATIONS GROUPING

COMMAND STRUCTURE			
OP Code 6 bits	Address 13 bits	Sequence tag 1 bit	Index tag 1 bit

A and B Registers: One word registers, programmed independently or combined for multiplication, division, square root, and double precision operations.
C Register: For multiplication, division, tally, and control.

Operation	Mnemonic Code	Numeric Code	Description
Arithmetic	ADD	14	Add
	SUB	15	Subtract
	DPA	16	Double Precision Add
	DPS	17	Double Precision Subtract
	SQR	30	Square Root
	VLS	30	Variable Length Square Root
	DIV	31	Divide
	VLD	31	Variable Length Divide
	MUP	32	Multiply
	VLM	32	Variable Length Multiply
	CLA	45	Clear A
	CLB	43	Clear B
	CLC	44	Clear C
	GTB	41	Gray to Binary
	CAM	56	Compare A and M
Transfer	TAN	35	Transfer if A Negative
	TBN	36	Transfer if B Negative
	TCN	34	Transfer if C Negative
	TRU	37	Transfer Unconditionally
	TOF	75	Transfer on Overflow
	TES	77	Transfer on External Signal
Loading & Storing	LDA	05	Load A
	LDB	06	Load B
	LDC	04	Load C
	LDP	07	Load Double Precision
	IAC	01	Interchange A & C
	IBC	02	Interchange B & C
	STA	11	Store A
	STB	12	Store B
	STC	10	Store C
	STD	13	Store Double Precision
	MCL	71	Move Command Line Block
	MLX	26	Move Line X to Line 7
Logical & Shifting	EBP	40	Extend Bit Pattern
	AMC	42	AND M & C
	AOC	46	AND OR Combined
	EXF	47	Extract Field
	NAD	20	Normalize and Decrement
	LSD	21	Left Shift and Decrement
	RSI	22	Right Shift and Increment
	SAI	23	Scale Right and Increment
Control	NOP	24	No Operation
	HLT	00	Halt
Input-Output	DIU	50	Disconnect Input Unit
	RTK	51	Read Typewriter Keyboard
	RPT	52	Read Paper Tape
	RFU	53	Read Fast Unit
	LAI	55	Load A From Input Buffer
	CIB	57	Clear Input Buffer
	WOC	6X	Write Output Character
	PTU	70	Pulse to Specified Unit
	BSO	72	Block Serial Output
	BSI	73	Block Serial Input

NUMERIC ORDER

Numeric Code	Mnemonic Code	Description
00	HLT	Halt
01	IAC	Interchange A & C
02	IBC	Interchange B & C
04	LDC	Load C
05	LDA	Load A
06	LDB	Load B
07	LDP	Load Double Precision
10	STC	Store C
11	STA	Store A
12	STB	Store B
13	STD	Store Double Precision
14	ADD	Add
15	SUB	Subtract
16	DPA	Double Precision Add
17	DPS	Double Precision Subtract
20	NAD	Normalize and Decrement
21	LSD	Left Shift and Decrement
22	RSI	Right Shift and Increment
23	SAI	Scale Right and Increment
24	NOP	No Operation
26	MLX	Move Line X to Line 7
30	SQR	Square Root
31	DIV	Divide
32	MUP	Multiply
34	TCN	Transfer if C Negative
35	TAN	Transfer if A Negative
36	TBN	Transfer if B Negative
37	TRU	Transfer Unconditionally
40	EBP	Extend Bit Pattern
41	GTB	Gray to Binary
42	AMC	And M & C
43	CLB	Clear B
44	CLC	Clear C
45	CLA	Clear A
46	AOC	AND OR Combined
47	EXF	Extract Field
50	DIU	Disconnect Input Unit
51	RTK	Read Typewriter Keyboard
52	RPT	Read Paper Tape
53	RFU	Read Fast Unit
55	LAI	Load A from Input Buffer
56	CAM	Compare A and M
57	CIB	Clear Input Buffer
6X	WOC	Write Output Character
70	PTU	Pulse to Specified Unit
71	MCL	Move Command Line Block
72	BSO	Block Serial Output
73	BSI	Block Serial Input
75	TOF	Transfer on Overflow
77	TES	Transfer on External Signal

Command List by Packard Bell Computer Corporation

OUTPUT

Media	Speed
Flexowriter	10 6 or 8 bit char/sec
High Speed Paper Tape Punch	110 6 or 8 bit char/sec
Magnetic Tape	2,000 7 bit char/sec
High Speed Serial	2 Mc bit, 83.3 KC word rate

The high speed (2 Mc) input and output is through a 2 Mc external shift register which can be loaded or unloaded in serial or parallel from equipment such as A to D, D to A converters, shaft encoders, etc.

Input and output can also be made through an 8 bit character buffer which is used for Flexowriter, Paper Tape, and Magnetic Tape input and output. For example, an adaptor card which connects our Model M3 A to D converter directly to the character buffer is available. 32 control output lines are available for use with the Pulse to Specified Unit command for control applications.

Both punched card and line printing equipment will be available by mid 1961.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

There are 400 transistors, 2,500 diodes, and 4 magnetostrictive delay lines in the system.

COST, PRICE AND RENTAL RATES

Model Number	Item	Sale Price	Monthly Lease Price
PB 250	**COMPUTER** with Flexowriter and 2320-word memory		
	PB 250-T In Free-Standing Case	$40,500	$1,230
	PB 250-R For Rack Mounting	39,500	1,200
	PB 250-R With Shelf & Slides for Rack Mounting Flexowriter	39,900	1,210
MSR-1	**MEMORY MODULE** (up to 256 words)	1,200	40
MTU-1	**MAGNETIC TAPE UNIT**	14,750	445
HSR-1	**PAPER TAPE READER** (300 characters/sec)	7,500	230
HSP-1	**PAPER TAPE PUNCH** (110 characters/sec)	4,950	155
MX-1	**MEMORY EXTENSION CHASSIS**	1,000	35
MT-1-250	**MODULE TESTER** (less oscilloscope)	3,000	——
SK-1	**SPARE PARTS KIT**	3,100	——
RR-1	**RACK**	500	——
PBS-1	**COMPUTER STAND**	250	——
PBD-1	**DESK**	500	——
——	**SIX ADDITIONAL SIGNAL INPUT LINES** (max. 3 sets)	300	10
FX-1R	**FLEXOWRITER** (with shelf & slides for rack mounting)	4,900	150
FX-1T	**FLEXOWRITER** (for table mounting)	4,500	140
PS-8	**BATTERY POWER SUPPLY** when included instead of a-c supply	1,500	45
HSB-1	**BUFFER REGISTER**	4,750	——

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE AND ARE F.O.B. OUR PLANT, LOS ANGELES, CALIFORNIA

CHECKING FEATURES

All operations involving the memory are parity checked. Checking is also done in the assembly program and in the subroutine.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.1 Kw
Volume, computer	7 cu ft
Area, computer	2.8 sq ft
Weight, computer	110 lbs

PRODUCTION RECORD

Number produced to date	3
Number in current operation	3
Number in current production	20
Number on order	30
Anticipated production rates	2 units per week
Time required for delivery	6 months

PERSONNEL REQUIREMENTS

Training made available by the manufacturer to the user includes a two weeks programming course and a two weeks maintenance course which are included in the price of the machine.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The PB 250 uses only solid-state circuitry and is completely modularized. The circuits used were developed for the TRICE DDA which operates at 3 Mc, and have been in operation for over two years.

For applications where power failures and resultant loss of memory cannot be tolerated a battery power supply is available which will operate the computer for several hours without line power.

The low component count less than 400 transistors and less than 2,500 diodes insure maximum reliability. The computer requires only 40 watts of power exclusive of input-output devices. This power is dissipated over a large area providing freedom from failure due to heating problems.

A built-in marginal circuit testing system combined with a diagnostic service routine permits the dynamic testing of all circuits in the computer and the identification of any drifting component. The entire computer consists of 115 plug-in modules, a plug-in magnetically regulated power supply, and a standard paper tape reader, paper tape punch, and electric typewriter. The computer proper requires only 30 watts of d-c power so that air conditioning is not needed. A battery supply is available.

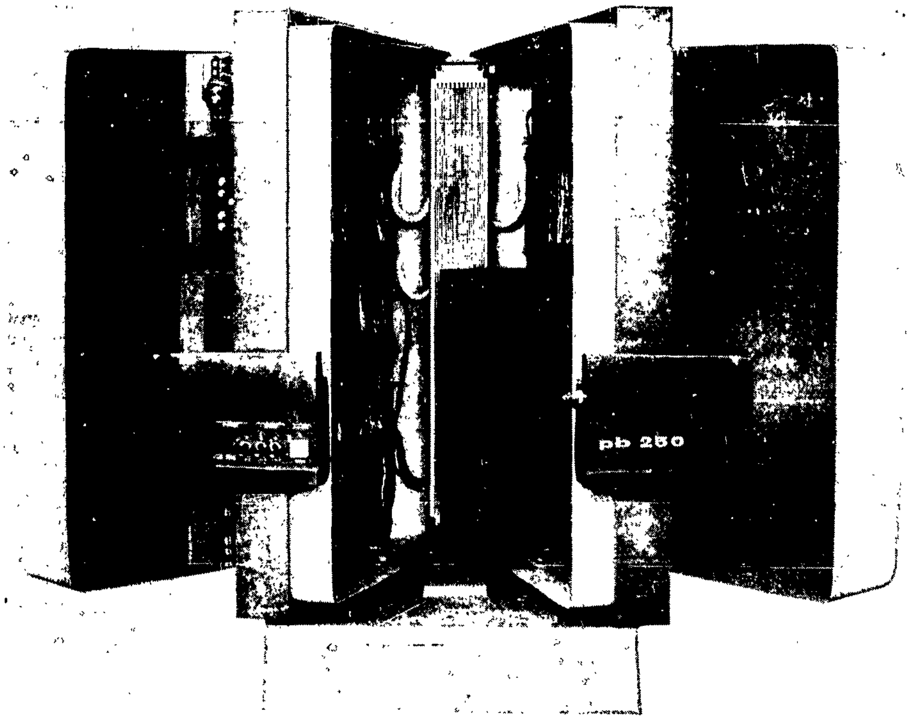


Photo by Packard Bell

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a 2 Mc clock frequency source providing microsecond speed at a price lower than previous microsecond machines, and expandable magnetostrictive delay line memory and a powerful command list including square root and gray-to-binary and double precision commands.

Other advantages include three methods of input-output; control lines, character buffer, and 2 Mc serial, plus inexpensive standard buffer equipment, making the computer adaptable to additional peripheral equipment.

The primary design objective of the PB 250 was to provide a computer that would be used as a standard systems component so that a large number of system requirements formerly satisfied only by a special purpose one-of-a-kind system can be met by the PB 250 plus the proper selection of off-the-shelf input-output equipment. The high speed, powerful command list, versatile input-output, and low price have met this objective.

Performance - The PB 250 operates at speeds comparable to those of large scale computers. The maximum operation rate is over 40,000 instructions per second. Typical times for a 22-bit word are:

addition and subtraction	12 microseconds
multiplication	276 microseconds
division	252 microseconds
square root	252 microseconds

The last three commands are variable in length. For example, the product of a 10-bit multiplier and a 22-bit multiplicand requires 132 microseconds. A repertoire of fifty-one commands permits the full speed of the PB 250 to be realized. Among these are double precision commands which automatically operate upon 44-bit words. Floating point routines operating on a 7-bit characteristic and a 37-bit (11 decimal digit) mantissa require less than 3 milliseconds.

Three complete input/output systems are integral to the computer. The first operates on characters of up to 8 bits at a maximum rate of 2,000 characters per second on input and 20,000 characters per second on output. Buffering permits the computer to operate simultaneously with input/output operations. The second system operates upon serial information at rates up to 85,000 words per second. The format of this information is automatically controlled by an internally stored mask. The third system consists of 30 input lines which can be sampled under program control and 32 output lines upon which signals can be placed under program control. These lines permit the computer to sense and control the state of external devices.

Ease of programming - The PB 250 is a single address computer with an index register. Program optimization in the PB 250 is provided by a unique minimum access scheme. If speed is not a consideration, the computer is treated as a straight-forward single address system. If, on the other hand, mini-

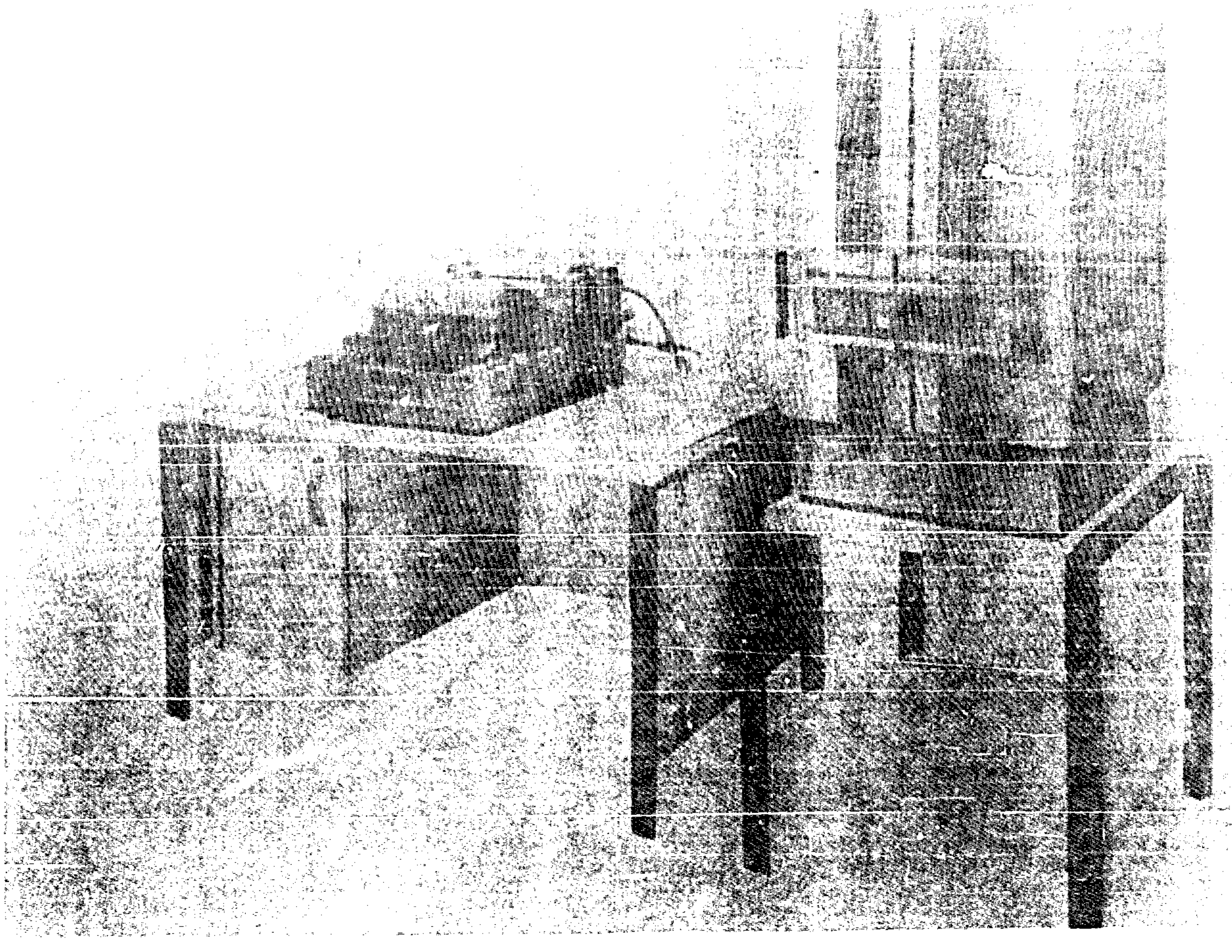


Photo by Packard Bell

mum access is a consideration, a sequence tag bit in the command word causes the computer to read the next command immediately following the execution of the indicated operation. The use of this sequence tag permits computation rates of up to 41,666 commands per second.

A special index register permits automatic address modification while optimum programming is maintained by selecting the optimum address in each memory line. Further, a single instruction permits shifting every word in a given line by one address position. Thus, optimum programming may be retained and the need for address modification eliminated.

Flexibility - The flexibility of the PB 250 makes it adaptable to a wide range of application. The memory is expandable from 2,320 words to 15,888 words. Further, the length of the additional memory lines is optional and so may be designed to fit any specific requirement. Magnetic core memory is also available as an option. The PB 250 has the widest range of auxiliary equipment of any general purpose digital computer, including punched card equipment and up to six magnetic tape units.

CINCH, the Floating Point Interpreter for the PB 250 general purpose digital computer, is designed to permit rapid programming of scientific and engineering problems and to allow persons generating problems to do the actual programming of the problems themselves. CINCH's structure permits those who have used the commonly accepted interpretive programs to learn CINCH coding quickly. This is made possible by the fact that CINCH was designed after consideration of other interpreters, combining the best of their features and adding new features that experience has shown to be desirable.

CINCH is a floating point interpretive system, which means "scaling" is no longer a problem. There is no need to keep track of number magnitude. In addition, CINCH offers 7 index registers for looping and program control. Debugging systems are offered, including a selective program trace and memory print. Input and output are convenient to use. Commands are written in an easy to remember notation. CINCH obeys the human law of self preservation in that it will not execute an instruction which would cause it to damage itself.

The CINCH interpretive memory can contain up to 4,095 words. One word is required to represent a command; two words are required to represent a floating point number.

PENNSTAC

Pennsylvania State (University) Automatic Computer

MANUFACTURER

Pennsylvania State University
Electrical Engineering Department

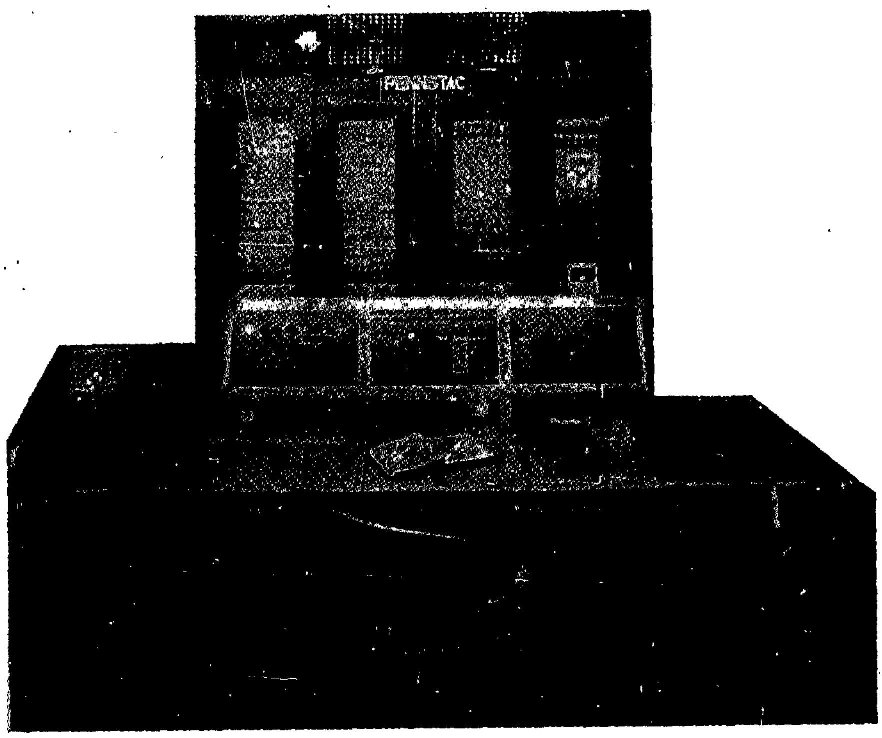


Photo by Pennsylvania State University

APPLICATIONS

System is used primarily for the education of digital computer engineers and the performance of research in digital computer design.

PENNSTAC has been designed to (1) carry out scientific computation and (2) be used in a classroom for teaching computer design and programming. For the second purpose mentioned, the following features have been included in the computer: (1) a visual display of the coded contents of the four registers; (2) a control panel reduced to the essentials for operation and enabling reduced-speed operation; (3) visible and accessible components, easily modified, and (4) an output system enabling instruction concerning communication between the computer and an asynchronous device.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	11
Decimal digits/instruction	11
Instructions/word	1
Instructions decoded	23
Arithmetic system	Fixed point
Instruction type	One-plus-one
Number range	-10^{10} to $+10^{10}$

Instruction word format

Operation Code	Tag	Next Instruction	Operand Address
X X	X	X X X X	X X X X

For example:

22	0	1345	2469

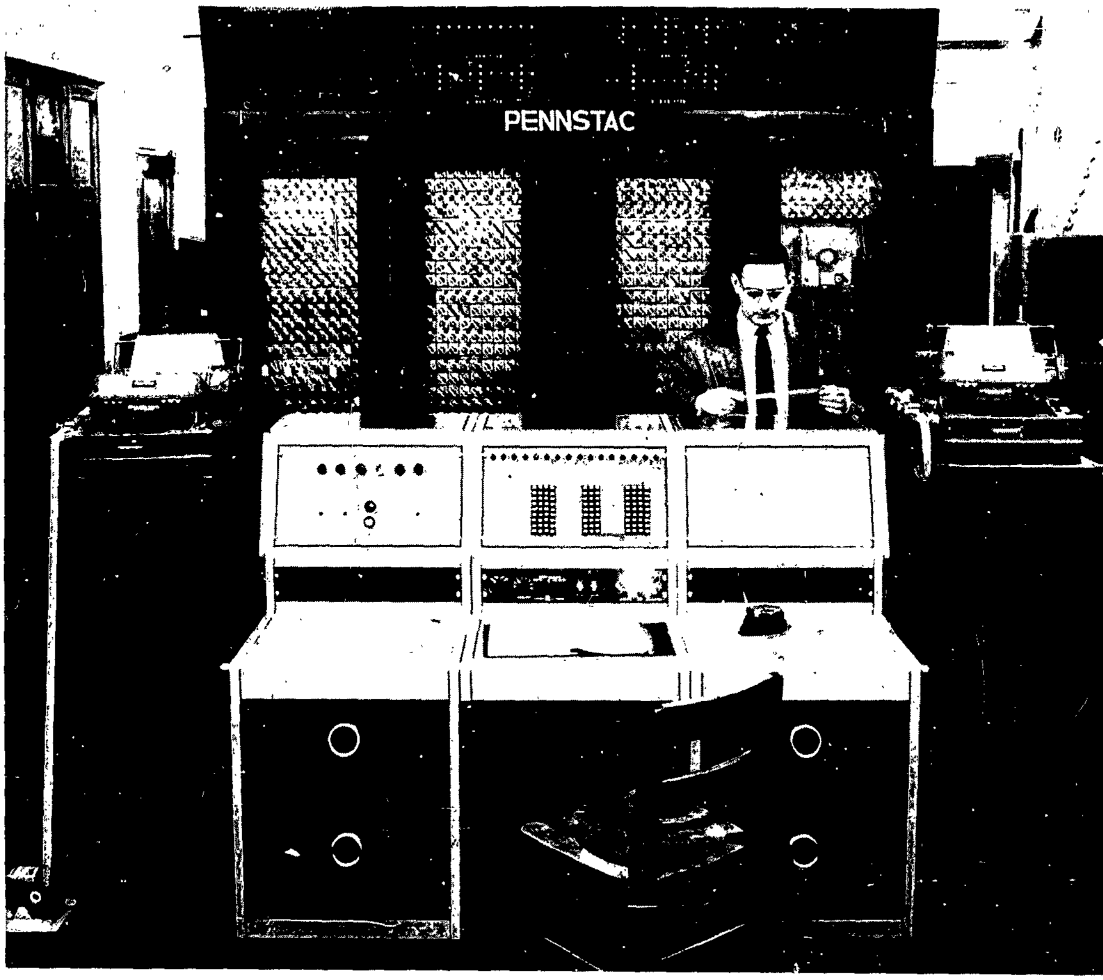


Photo by Pennsylvania State University

This instruction states: Add (22) the number at (2469) to the number in the A-register, leave the result in the A-register, and take the next instruction from drum location 1345. The tag digit is not used.

Registers
- A-register - accumulator
- B-register - receives information from drum
- C-register - accumulator for holding information to be stored on the drum
- D-register - holds instruction

The internal number system is the 2*421 binary coded decimal system. There are four bits per decimal digit.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec Average	Exclud. Stor. Access Microsec Average	Exclud. Stor. Access Microsec Maximum
Add	3,445	94	4,700
Mult	5,335	2,985	5,969
Div	7,426	5,076	10,152

Construction (Arithmetic unit only)	117 vacuum tubes
Arithmetic mode	Parallel in binary Serial in decimal
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No of Words	No. of Digits	Access Microsec
IBM 650 Drum	2500	27,500	2350 (Average)

INPUT

Medium	Speed
Paper Tape	440 char/sec

Ferranti photoelectric reader. The punched paper tape is standard 7/8 inch tape. Six channels are used. The tape is prepared by a F299MA Burroughs Sensimatic.

OUTPUT

Medium	Speed
Paper Tape (Flexowriter)	10 char/sec
Paper Tape (Teletype)	60 char/sec

Teletype model BRPE2

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
2C51	264
5887	200
12BH7	796
6L6	42
6W6	40
Total	1,342
Diodes	
H02077	5,768
Transistors	
2N94A	6

CHECKING FEATURES

Checking features include sensing for wrong combination in the four registers, exceed capacity, unusually lengthy instruction time, divide by zero, read-in false start, and synchronism alarms.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	7.2 Kw	9 KVA	0.8 pf
Power, air conditioner	7.2 Kw	10.2 KVA	0.7 pf
Volume, computer		320 cu ft	
Volume, air conditioner		72 cu ft	
Area, computer		80 sq ft	
Area, air conditioner		13 sq ft	
Room size		65 ft x 23 ft	
Floor loading		3.3 lbs/sq ft	
		110 lbs, concen max	
Capacity, air conditioner		12.5 Tons	
Weight, computer		3,500 lbs	
Weight, air conditioner		1,500 lbs	

Overhead conduits for power, signal wires, and air conditioning.

PRODUCTION RECORD

Number produced to date	1
Number in operation	1

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Supervisors	1/2
Programmers	1
Clerks	1
Operators	1
Engineers	1 1/2
Technicians	2

ADDITIONAL FEATURES AND REMARKS

General Information

The new system presents two major modifications. First is the Internal Output control by means of which the output is controlled almost entirely by the program. The format switch and the format tape will be eliminated. Second will be the addition of a second output device, a sixty-digit-per-second Teletype Punch. The output information from the Teletype Punch will be in the form of punched paper tape. The programmer can select as the output device either the Teletype Punch or the ten-digit-per-second Flexowriter.

2*421 coded decimal number system used on PENNSTAC

Decimal Equivalent	2*421 Code
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	1 0 1 1
6	1 1 0 0
7	1 1 0 1
8	1 1 1 0
9	1 1 1 1
Wrong Combination	
" "	1 0 0 0
" "	1 0 0 1
" "	1 0 1 0
" "	0 1 0 1
" "	0 1 1 0

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $100,000.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System has been in operation since 1955.

Table of Operations of PENNCODE
Basic PENNCODE

Operation Code	Operation	Description
50	Add	$A + B \rightarrow K$
51	Subtract	$A - B \rightarrow K$
52	Multiply	$A \cdot B \rightarrow K$
53	Divide	$A \div B \rightarrow K$
54	Add Absolute	$A + \|B\| \rightarrow K$
55	Subtract Absolute	$A - \|B\| \rightarrow K$
56	Addiply	$K + AB \rightarrow K$
57	Subtiply	$K - AB \rightarrow K$
63	Square Root	$\sqrt{A} \rightarrow B, K$
64	Compare	If $A < \|K\|$ take next instruction from $\hat{B}$.
65	Move	$A \rightarrow B, K$
67	Transfer Negative	If $K < 0$ take next instruction from $\hat{B}$. If $K \geqslant 0$ take next instruction from $\hat{A}$.
68	Transfer Non Zero	If $K \neq 0$ take next instruction from $\hat{B}$. If $K = 0$ take next instruction from $\hat{A}$.
69	Unconditional Transfer	Take next instruction from $\hat{B}$.
70	Return Jump	Jump from present instruction, which is at $\hat{\partial}$, to $\hat{A}$. Upon reaching $\hat{B}$ return to $\hat{\partial} + 1$.
71	Escape	Take next instruction, which is in PENNSTAC code from $\hat{B}$. On reentering PENNCODE at 2000 the next PENNCODE instruction will be taken from $\hat{A}$.
72	No operation	
73	Read In	Read in from paper tape and then take next instruction from $\hat{B}$.
74	Read Out	Read out $\hat{A}$ words from consecutive locations starting at $\hat{B}$.
75	Stop	
76	Conditional Stop	Stop if code switch 1 is on.
77	Translate In	Convert B from fixed point to floating point using the exponent $\hat{A}$ and $\rightarrow$ K., i.e., the floating number $B \cdot 10^{(\hat{A}-50)}$ will be formed.
78	Translate Out	Convert K from floating point to fixed point using the exponent $\hat{B}$ and $\rightarrow A$, i.e. Store $K' \cdot 10^{(Z-B)}$
	PENNCODE Functions	
58	Sine	$\mathrm{Sin}\ A \rightarrow B, K$
59	Cosine	$\mathrm{Cos}\ A \rightarrow B, K$
60	Logarithm	$\mathrm{Ln}\ A \rightarrow B, K$
61	Exponential	$\mathrm{Exp}\ A \rightarrow B, K$
62	Arc Tangent	$\mathrm{Tan}^{-1}\ A \rightarrow B, K$
	Double Precision PENNCODE	
40	D. P. Add	$A + B \rightarrow K$
41	D. P. Subtract	$A - B \rightarrow K$
42	D. P. Multiply	$A \cdot B \rightarrow K$
43	D. P. Divide	$A \div B \rightarrow K$
66	D. P. Move	$A \rightarrow B, K$

FUTURE PLANS

Plans call for the addition of an IBM 727 Magnetic Tape Unit, and revision of the input system to accommodate variable-length-of-field read in.

INSTALLATIONS

Pennsylvania State University
University Park, Pennsylvania

PERK I II

Performance Computer Models I II

MANUFACTURER

Automation Management Incorporated

APPLICATIONS

Systems are designed and used for the reporting of percentage of standard performance of production operation; compares actual production rate against standard production rate and records on continuous chart whether efficiency is zero (downtime), below, at, or above normal.

System could also be adapted to compare other ratios, e.g. plane ground speed against air speed or planned speed, same in fuel consumption, steps in checking out launching of missile, et al.

Perk I samples latest rate, while Perk II gives cumulative (integrated) results.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Decimal	
Arithmetic system	Floating point	Perk II
	Fixed point	Perk I

ARITHMETIC UNIT

Arithmetic unit consists of vacuum tubes, diodes, stepping relay, relays, and potentiometers.

Timing	Synchronous
Operation	Concurrent

STORAGE

Media		No. of Digits
Perk I	stepping relay	100
Perk II	potentiometers	500,000

INPUT

Input may be any sensor, e.g. a limit switch, photo cell, transducer, or flow meter. Input speed is at 900 to 10,000 counts/hour. System can count considerably faster on special models.

OUTPUT

Output is on a 2.5 inch pressure-sensitive chart paper in a galvonometer recorder. Paper speed is at 3 inches/hour. Output can be read and/or displayed by any voltage translating device. Other paper feed speeds available on request.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	5
Diodes	1

Relays, and other standard electronic components are used.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Volume, computer	1 cu ft
Area, computer	1 sq ft
Weight, computer	20 lbs

A wall outlet is required.

PRODUCTION RECORD

Number produced to date	1
Anticipated production rates	10 - 1960
	100 - 1961
Time required for delivery	1 month

COST, PRICE AND RENTAL RATES

Perk costs $1,000.
Sensors and wiring cost $5 to $500.
Perk rents at $50/month.
Sensors and wiring rent at $.50 to $50/month.

User ships Perk unit, air-express collect, to plant. Repair and service is at $8/hour. Automation Management Incorporated will ship air express prepaid, back to user.

PERSONNEL REQUIREMENTS

Only application engineer is needed at installation and is performed by A.M.I. personnel at $15/hour. Automatic operation. Chart paper is replaced after 250 running hours.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability include time-tested, simple, components used to well under their capacity.

ADDITIONAL FEATURES AND REMARKS

System provides for management by exception, instead of demanding computing by foremen, time and motion study engineers, production planners, and other executives. System allows the loss or profit of an operation to be viewed continuously and losses corrected immediately and successful methods of operation strengthened and repeated.

FUTURE PLANS

Plans for new components and anticipated modifications include wider input speed ranges, another model with single input speed and, hence, lower price, and self-correcting systems, i.e. the output will control those factors influencing the input so the process will seek the optimal level of performance. Uses in laboratory and military services are planned.

PHILCO 1000

Philco Transistor Automatic Computer 1000

MANUFACTURER

Philco Corporation

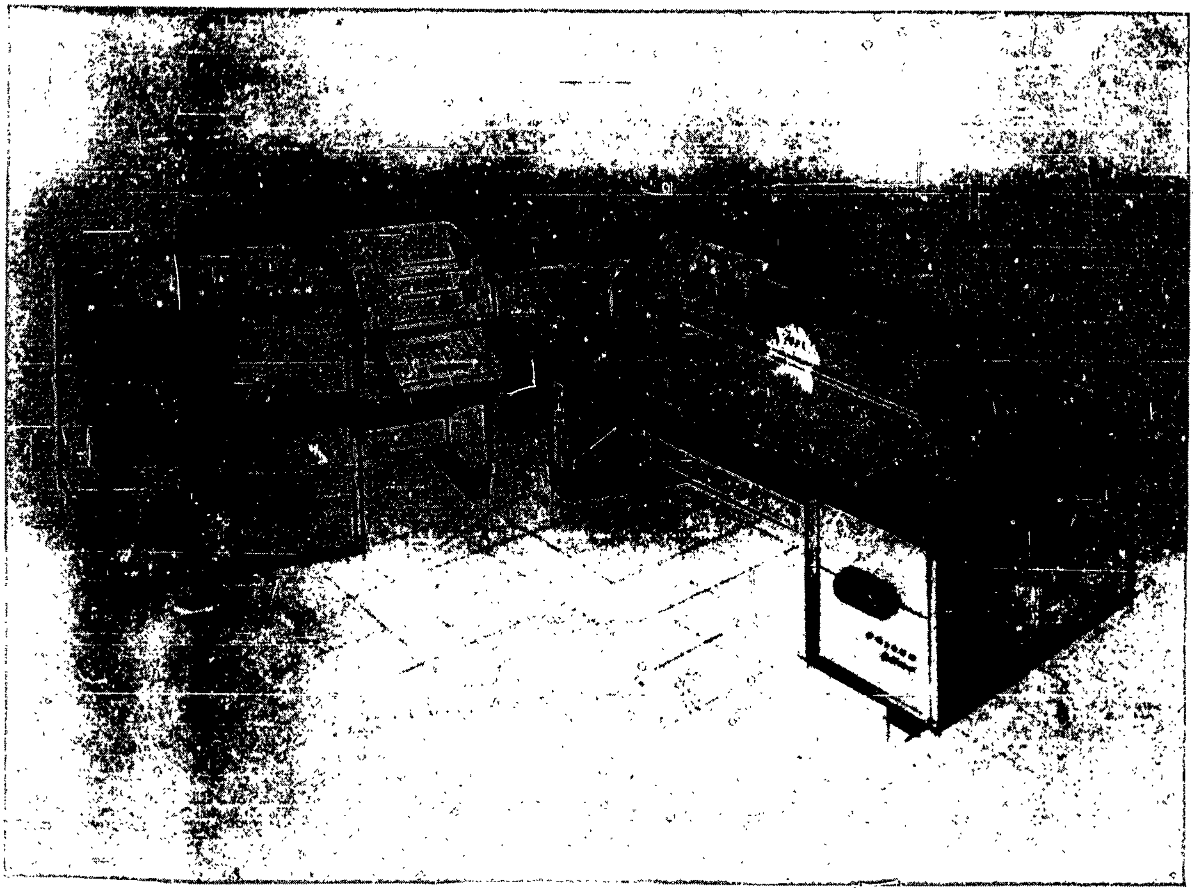


Photo by the Philco Corporation

APPLICATIONS

Manufacturer
Primarily scientific applications, some commercial or industrial applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36
Instructions/word	1
Instruction type	Two address

Code will include two 12-binary digit addresses, two 3-binary digit address modifiers, and a 6-binary digit command.

ARITHMETIC UNIT

		Exclud Stor Access Microsec
Add		5.5
Mult		130 avg.
Div		200
Construction	Transistors	
Arithmetic mode	Parallel	

Maximum multiply time excluding storage access is 200 microseconds. Ones complement binary arithmetic is used

STORAGE

Medium	Words	Digits
Magnetic Core	4,096	147,456

Cycle time is 12 microseconds.

INPUT

Media	Speed
Perforated Tape Reader	60 char/sec
Teletype Model 28 Keyboard	Manual

OUTPUT

Media	Speed
Perforated Tape Punch	60 char/sec
Teletype Model 28 Page Printer	

Either 5 or 7 level tapes may be used. Punched card equipment, magnetic tape and magnetic drum may be added, if desired.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

All transistor circuits are used in arithmetic and storage units.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

System requires approximately 1.2 Kw. The total volume occupied by the arithmetic section, storage section, power supplies, control panel and ventilating equipment is about 36 cubic feet.

ADDITIONAL FEATURES AND REMARKS

A cathode ray storage address reference indicator is included in the system.

INSTALLATIONS

Philco Corporation
3900 Welsh Road
Willow Grove, Pennsylvania

PHILCO 2000

Philco Transistorized Automatic Computer
(TRANSAC S-2000)

MANUFACTURER

Philco Corporation

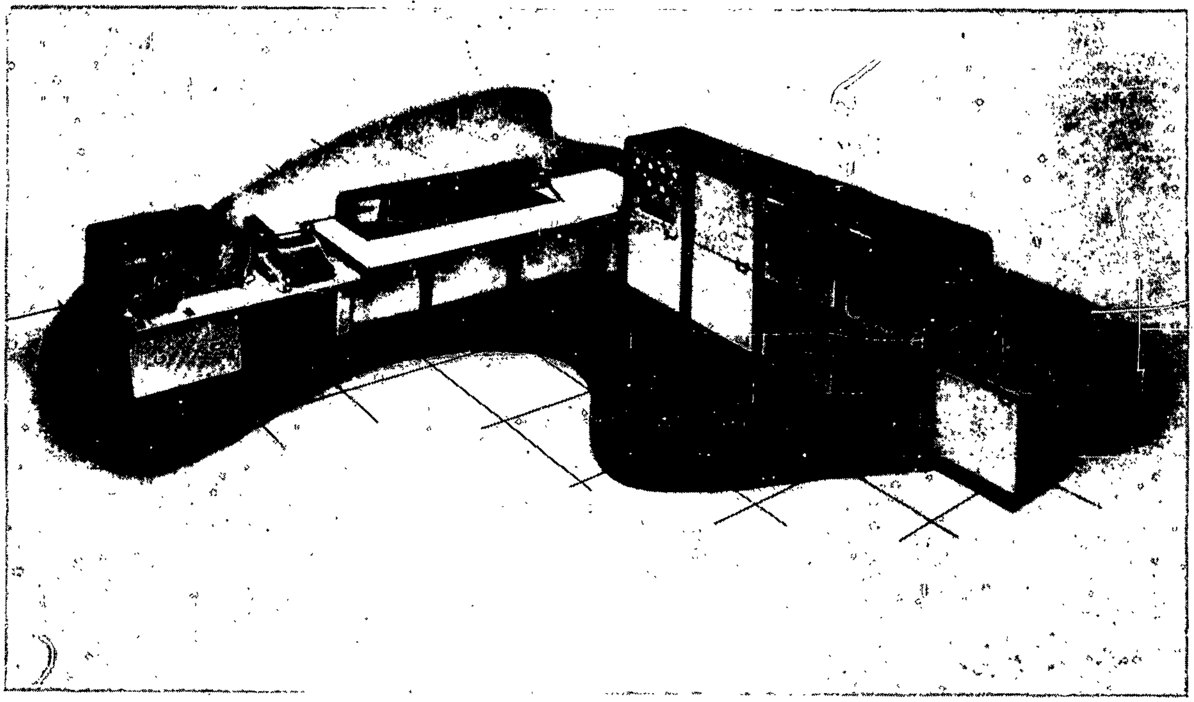


Photo by Philco Corporation

APPLICATIONS

Manufacturer

The Philco 2000 Electronic Data Processing System is an all purpose computing system. The design of the system has been planned so that sizes and equipment may be varied to suit the specific installation. This means that the system may be used equally well with data processing and scientific applications. The Philco 2000 Electronic Data Processing System uses asynchronous logic which reduces computer operating time and allows new components to be added without redesigning the equipment.

U. S. Army Signal Missile Support Agency
White Sands Missile Range

Presently located at Philadelphia, Pennsylvania, equipment is used for the solution of differential equations, statistical analysis of scientific data, computation of scientific tables, and additional scientific and engineering uses in connection with Signal Corps research and development activities in support of the Army missile program.

General Electric Company

Located at the General Electric Company Knolls Site, Niskayuna, New York, the system is used for reactor core design, thermal and mechanical problems (associated), shielding studies, power plant systems analysis, maneuvers, accidents, etc, nuclear physics, and data reduction and processing from prototype operations.

Westinghouse Electric Corporation
Bettis Atomic Power Laboratory

Located at Pittsburgh, Pennsylvania, the system is used for nuclear design calculations, thermal and hydraulic calculations, analysis and experimental data reduction, reactor and plant kinetics, and miscellaneous engineering calculations.

System Development Corporation

System is used for systems simulation research.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary, binary coded decimal and alphanumeric
Binary digits/word	48
Binary digits/instruction	24
Instructions/word	2
Instructions decoded	225, including 59 floating point instructions
Arithmetic system	Floating and fixed
Instruction type	One address

Addressing can be modified by index registers.

Number range Up to $10^{\pm 616}$ w/floating point option

Instruction word format

0 15	16 22
Address	Command

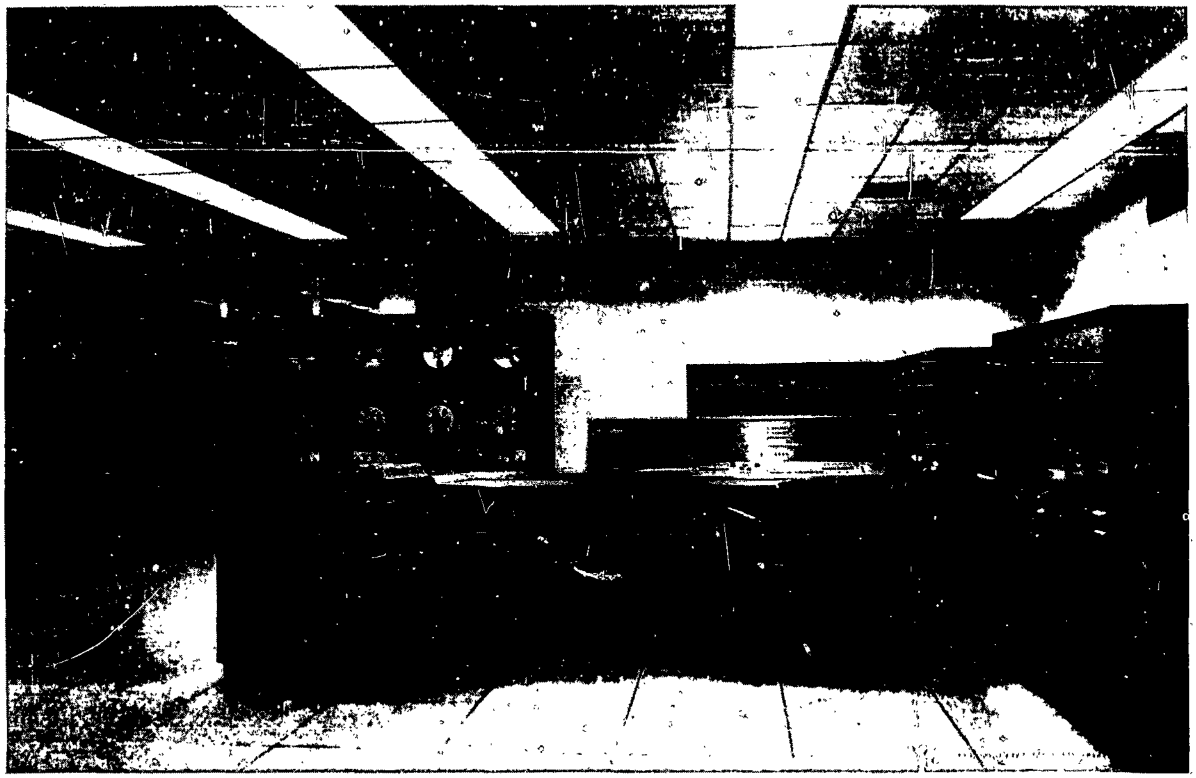


Photo by the Philco Corporation

System uses an automatic assembling and compiling system called TAC which permits the programmer to write programs in a simple mnemonic code. TAC also has an ever expanding library of routines. It also has available ALTAC, an algebraic translator.

There is one 48 bit register, three 24 bit registers, and up to 32 optional index registers.

The program section has asynchronous logic which means that each operation within each instruction starts as soon as the preceding operation is completed.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	3.7 or 11.7	1.7
Mult	42.3 or 50.3	40.3
Div	45 or 53.0	43

Construction (Arithmetic unit only)

Transistors	Approximately 20,500
Condenser-diodes	130
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Concurrent

Sequential instructions, concurrent input-output.

The arithmetic section employs a carry complete signal which terminates each arithmetic operation as soon as it is completed. This increases the speed of all arithmetic operations.

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4,096 to 32,768	196,608 to 1,572,864	10 or 2
Magnetic Drum	32,768 to 1,048,576	1,572,864 to 50,331,648	

Drum access is 25,000 microseconds for the first word and 16 microseconds for each additional word.

Magnetic Tape

No. of units that can be connected	256 Units
No. of char/linear inch of tape	750 Alphanum char/in
Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	0.9 Inches
Tape speed	120 Inches/sec
Transfer rate	90,000 Alphanum char/sec
Start time	2.5 Millisec
Stop time	2.5 Millisec
Average time for experienced operator to change reel of tape	30 Seconds

Physical properties of tape

Width	1 Inch
Length of reel	3,600 Feet
Composition	Mylar base tape

With the multiple processing techniques used with the Philco 2000 System it is possible to have as many as 64 tape units processing data simultaneously. Transfer rate can be increased to 360,000 alphanumeric characters per second if full advantage is taken of the multiple processing techniques.

U. S. A. Missile Support Agency

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	8,192	48 bits/word	10 (max)

Nine magnetic tape units are used "on line" as intermediate storage. Capacity of one 3,600 foot reel is in excess of 2 million characters.

General Electric Company

Magnetic Core	32,768	48 bits/word	10

2 microsecond memory on order for January 1961.

WEC, Bettis AP Lab.

Magnetic Core	32,768	48 (binary)	10
Magnetic Tape	Approx. 40 million	48 (binary)	Serial

Core store will be changed to 2 microsecond unit in December 1960; size will remain 32,768 words.

INPUT

Manufacturer

Media	Speed
Punched Cards	2,000 cards/min

80 columns read in any code.

Punched Tape	1,000 char/sec

Punched in 5, 6, 7, or 8 channel tape.

Magnetic Tape	90,000 char/sec
UBC	90,000 char/sec

Characters are alphanumeric characters. Both cards and paper tape may be either on-line or transferred to magnetic tape to make use of 90,000 character transfer rate.

U. S. A. Missile Support Agency

Paper Tape Reader	1,000 char/sec
Magnetic Tape (AMPEX FR 300)	90,000 char/sec

General Electric Company

Magnetic Tape	90 kilocycles/sec

16 tapes are on the system any 4 of which may be multiplexed.

Off-Line Card Reader	2,000 cards/min

WEC, Bettis AP Lab.

Magnetic Tape	6,400 words/sec

Figures are average for each of four channels.

Cards (80-column)	2,000 cards/min

OUTPUT

Manufacturer

Media	Speed
Punched Card	250 card/min
Punched Tape	60 char/sec
Magnetic Tape	90,000 char/sec
High Speed Printer	15 lines/sec

Characters are alphanumeric characters.

The input and output devices used with the Philco 2000 System are connected to a specialized buffering device which permits transfer of data between input and output devices when used off-line and between the computer and any input or output device when used on-line. The buffering device, called the Universal Buffer Controller (UBC) controls the transfers so that the transfers are made at the maximum speed, 90,000 cps.

U. S. A. Missile Support Agency

Paper Tape Punch	60 char/sec
High Speed Printer	900 lines/min

General Electric Company

High Speed Printer	900 lines/min

The Anelex printer is used off line.

WEC, Bettis AP Lab.

Media	Speed
Magnetic Tape	6,400 words/sec

Speed is average on each of four channels.

Cards (80 column)	100 cards/min
Line Printer	900 lines/min

A 64 character alphabet is used.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity	Use
Tubes	120	Printer Hammer Drivers
	32	Paper Tape Power Supply
	33	Mag Tape Power Supply
	265	Other
Total	450	
Diodes	1,200	
Transistors	56,000	
Ferrite Cores	196,608 to 1,572,864	

Above figures are with ten magnetic tape units.

CHECKING FEATURES

Manufacturer

All input and output devices have comprehensive checking facilities.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

KVA, computer	50
Area, computer	1,600 sq ft
Room size, computer	40 ft x 50 ft
Floor loading	52 lbs/sq ft
	264 lbs concen max
Weight, computer	2,100 lbs

Air conditioner is obtained by user. Capacity of 12 Tons i.e. 136,000 BTU/hr.

U. S. A. Signal Missile Support Agency

KVA, computer	25.9
Power, air conditioner	4.5 Kw
Volume, computer	6,500 cu ft
Area, computer	1,300 sq ft
Room size	1,600 sq ft
Volume, air conditioner	50.75 cu ft
Area, sq ft	7.25 sq ft
Capacity, air conditioner	6 Tons
Weight, computer	16,250 lbs
Weight, air conditioner	876 lbs
Floor loading	32.5 lbs/sq ft
	51.6 lbs/sq ft concen max
	No castor loads

Above figures are for the SMSA configuration. Computer air conditioner is used as standby for room air conditioner. No false floor, false ceilings, or air plenums are required. Humidity controls are required.

General Electric Company

KVA, computer	45.1
Area, computer	1,554 sq ft
Floor loading	60 lbs/sq ft
	115 lbs concen max
Capacity, air conditioner	80 Tons
Weight, computer	21,472 lbs

Only small site preparation and modification were required, since area was previously occupied by an IBM 704. About 13 tons of air conditioning are needed for the system.

PRODUCTION RECORD

Time required for delivery 12 months

COST, PRICE AND RENTAL RATES

Signal Missile Support Agency

GSA No.	Model No.	Description	Monthly Rental
		Arithmetic and Logical Units	
1	210	Arith & Ctl Unit, Console & Typewriter	$7,100
2	1000	Floating Point Option	650
3	1011	Index Registers (Block of 8)	900
		Ten-Microsecond Magnetic Core Storage Units	
8	2208	Magnetic Core Stor. Unit (8192)	$5,800
		Input-Output Units	
11	234	Magnetic Tape Unit	$7,650
12	235	Input-Output Processor (16x1)	3,300
16	240	Punched Paper Tape System	1,800
18	257	Printer System	6,500
		Total	$33,700

General Electric Company

Basic system with 16 magnetic tape stations, a 32,768 word magnetic core memory, and 16 x 4 tape multiplexing (input-output processor) rents at $67,000/month.

IBM 026's, 407, 519, sorter and interpreter rents at $2,000/month.

Service included in rental.

WEC, Bettis AP Lab.

Computer with 32,768 core memory and 16 x 2 tape stations rent at $53,000/month.

Off-line printer, reader, punch, and 2 tapes rent at $9,000/month.

Service included in rentals.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	2	3
Analysts	1	2	3
Programmers	2	4	6
Coders	2	4	6
Clerks	0	0	0
Librarians	1	2	3
Operators	2	4	6
Engineers	2	4	6
Technicians	1	2	3
In-Output Oper	1	2	3
Tape Handlers	0	0	0

Extensive training in programming and operating techniques made available by the manufacturer. In addition, seminars are held periodically at the new computer plant in Willow Grove, Pennsylvania.

Signal Missile Support Agency

	One 8-Hour Shift	
	Used	Recommended
Supervisors	3	3
Analysts	0	0
Programmers	12	12
Coders	0	8
Clerks	1	1
Librarians	0	1
Operators	3	4
Engineers	3	3
Technicians	0	0
Input-Output Oper	0	2
Tape Handlers	0	0

Three engineers are provided by contractor as part of lease agreement.

Operation tends toward closed shop.

Methods of training used includes on-the-job and manufacturer sponsored training.

General Electric Company

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	U	R	U	R	U	R
Supervisors	3	3	3	3	3	3
Programmers	20	30	20	30	20	30
Operators	3	3	5	5	7	7
Technicians	4	4	4	4	4	4
In-Output Oper	1	1	2	1	3	2
Tape Handlers	1	1	2	2	3	3

Operation tends toward closed shop.

Methods of training includes on-the-job and occasional internal courses.

WEC, Bettis AP Lab.

	Two 8-Hour Shift
Supervisors	3
Analysts	3
Programmers	40
Clerks	8
Librarians	1
Operators	4
Technicians	1
In-Output Oper	2

Operation tends toward closed shop.

Methods of training used includes informal seminars and individual study.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

The asynchronous feature of the Philco 2000 System means fewer components and consequently higher reliability.

The modular construction of the system facilitates maintenance.

Comprehensive diagnostic routines are provided to quickly locate any possible malfunction.

The all-transistor construction insures greater reliability.

Periodic preventive maintenance performed by trained Philco customer engineers on all electromechanical devices insures maximum reliability of these units.

Signal Missile Support Agency

Time is available for rent to qualified outside organizations.

During past 6 months 165 hours of computer time have been used on Philco 2000 as part of the customer service provided. No actual operation figures are available since the computer has not been installed at White Sands.

General Electric Company

Passed Customer Acceptance Test 8 Jun 60

There is not sufficient experience to quote figures. The machine does exhibit exceptional reliability.

WEC, Bettis AP Lab.

Good time 70 Hours/Week (Average)
Attempted to run time 80 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.88
Above figures based on period 4 Apr 60 to 30 Aug 60
Passed Customer Acceptance Test 3 Apr 60
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Signal Missile Support Agency
Outstanding features include solid state computer, asynchronous mode of operation, and high tape transfer rate. Unique system advantages include a real time capability.

General Electric Company
Outstanding features include asynchronous operation, fast tapes, and complete transistorization. Complete set of instructions for testing tape errors, or tape unavailability, which allow program action.
Unique system advantages include16 x 4 input-output processor, which allows 4 tape multiplexing, and repeat mode, which allows repetition of any instruction pair without the necessity of an accessing pair each time. This feature is exceptionally good for sorting.
Optional equipment used includes a programmable calendar clock, paper tape input and output, and a real time channel.

WEC, Bettis AP Lab
Outstanding features include flexible tape addressing, a long data word, and very compact programs. Unique system advantages includes flexible tape addressing.

FUTURE PLANS

Signal Missile Support Agency
Eventual modification of the system to include cards is anticipated. The real time capability is to be exploited.

General Electric Company
A printer modification which would allow plotting has been proposed by the user.

WEC, Bettis AP Lab.
A two microsecond (four-section) 32,768 word core store will be installed.

INSTALLATIONS

U. S. Army Signal Missile Support Agency
White Sands Missile Range, New Mexico

General Electric Company
Knolls Atomic Power Laboratory
P. O. Box 1072
Schenectady, New York

Westinghouse Electric Corporation
Bettis Atomic Power Laboratory
P. O. Box 1468
Pittsburgh 30, Pennsylvania

System Development Corporation
Systems Simulation Research Laboratory
Santa Monica, California

U. S. Naval Supply Center
Oakland 14, California

AVCO
Research and Advanced Development Division
201 Lowell Street
Wilmington, Massachusetts

United Aircraft Corporation
Research Laboratories
400 Main Street
East Hartford 8, Connecticut

PHILCO 3000

Philco Model 3000 Computing System

MANUFACTURER

Philco Corporation

APPLICATIONS

The Philco 3000 is a solid-state general purpose digital computer for programmed control and computation applications. A single cabinet houses computer, memory, console and power supply. The computer will accept and transmit control impulses from and to external devices. Elements which might effect a potentially explosive atmosphere are hermetically sealed. The computer may be controlled from the console, a remote console, or a Flexowriter input-output unit.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20 + sign + parity
Binary digits/instruction	20
Instructions per word	1
Instructions decoded	16 basic, expandable to over 60
Arithmetic system	Fixed point
Instruction type	One address or 1 + 1 at option
Number range	$\pm 1 \times 10^{-6}$

Instruction word format

21 15	14 8	7 1	0
Track	Sector	Command	Sign

When bit number 1 is set equal to 0, a single address instruction is interpreted. When bit 1 is set equal to 1, a 1 + 1 address instruction is interpreted.

Automatic built-in subroutines includes a square root command.

Registers and B-boxes include 1 instruction register, 3 arithmetic shift registers, 2 four-word rapid access storage locations, 1 six-bit I/O register, and 1 14-bit program address counter.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	924	132
Mult	4,224	2,772
Div	4,224	2,772

Construction (Arithmetic unit only)

Transistors	1,300
Condenser-diodes	4,000
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Binary Digits	Access Microsec
Magnetic Drum	8,064-16,256	177,408 to 357,632	8,448
Magnetic Drum	4	88	264

The drum has 64 tracks for recording information - 63 tracks for general storage; 1 rapid-access revolver loop. The general storage tracks contain 128 words of data, the revolver loop 4 words.

INPUT

Media	Speed
Punched Paper Tape (Flexowriter)	10 char/sec
Console Keyboard	
External Shift Register	162 kilocycles/sec

Available with serial input to the accumulator at the basic clock freq. using control signals from external input source.

OUTPUT

Media	Speed
Paper Tape and Page (Flexowriter)	10 char/sec
Cathode Ray Tube	Two register display
External Shift Register	162 kilocycles/sec

Provides serial output of the accumulator at the basic clock freq. with control signals to external device.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
CRT	1
Diodes	4,200
Transistors	1,500

CHECKING FEATURES

Parity check is made on all word transfers to and from the drum. An optional safety device is a control switch which removes write capability for 1/2 drum capacity to protect program storage.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.7 Kw	0.9 pf
Volume, computer	19 cu ft	
Area, computer	4.5 sq ft	
Floor loading	112 lbs/sq ft	
	150 lbs concen max	
Weight, computer	500 lbs	

Above figures do not include Flexowriter, Input or Output Equipment, and console table. No air conditioning is required for operation at ambient temperatures below 104°F. Power is 115 ±5 volts, single phase at 60 cps.

PRODUCTION RECORD

Number produced to date	2
Number in current operation	1
Number in current production	10
Number on order	10
Anticipated production rates	6 per year
Time required for delivery	10 months

PERSONNEL REQUIREMENTS

Device is a process control computer therefore programming is semi-permanent and requires only one (1) operator per shift for monitoring.

PHILCO CXPQ

Philco Transistorized Automatic Computer CXPQ

MANUFACTURER

Philco Corporation

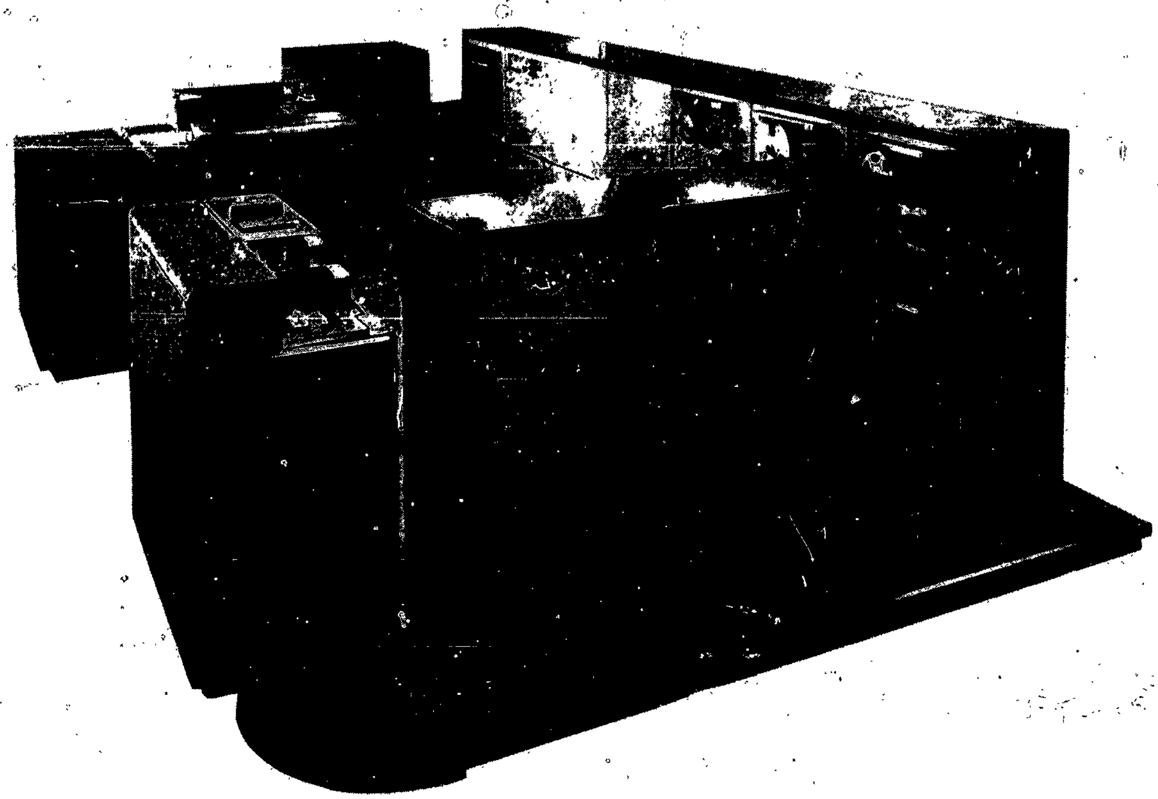


Photo by U. S. Navy David Taylor Model Basin

APPLICATIONS

David Taylor Model Basin

Located at the David Taylor Model Basin, the system is used for the solution of naval engineering problems.

PROGRAMMING AND NUMERICAL SYSTEM

David Taylor Model Basin

Internal number system	Binary
Binary digits/word	48
Binary digits/instruction	24
Instructions/word	2
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-(1 - 2^{-47}) \leq x (1 - 2^{-47})$

Registers and B-boxes

7 Index Registers
1 Toggle-switch Intervention Register
1 D-Register (Buffer)

ARITHMETIC UNIT

David Taylor Model Basin

	Incl Stor Access Microsec
Add	45

Operation time assumes an operand is in the accumulator to start the time to fetch an instruction, an operand, execute, and place results in storage.

Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Dequential

STORAGE

David Taylor Model Basin

Media	No. of Words	No. of Bin Dig/Word	Access Microsec
Core	4,096	48	12
Drum	16,384	48	16

Magnetic Tape 5,000 blocks at 128 words/block

No. of units that are connected	3 Units
No. of char/linear inch of tape	210 Char/inch
Channels or tracks on the tape	13 Tracks/tape
Blank tape separating each record	Approx 2 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Char/sec
Start time	3 - 5 Millisec
Stop time	3 - 5 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	1.0 Inches

A single reel contains 4,000 blocks, 128 words/block, 8 char/word.

INPUT

David Taylor Model Basin

Media	Speed	
Paper Tape	200 char/sec	8 char/word
Keyboard (Flexowriter)	10 char/sec	8 char/word
Card (IBM)	200 card/min	10 words/card

OUTPUT

David Taylor Model Basin

Media	Speed	
Paper Tape	120 char/sec	8 char/word
Typewriter (Flexowriter)	10 char/sec	8 char/word
Card (IBM)	100 card/min	10 words/card

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

David Taylor Model Basin

Type	Quantity
Tubes	48
Diodes	115
Transistors	5,500

Tubes are used only in the magnetic tape and paper tape units, about 12 tubes each.

CHECKING FEATURES

David Taylor Model Basin

Magnetic tape error detection and correction.
Improper command.
Overheat alarm.
Non-existent peripheral equipment detection.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

David Taylor Model Basin

Power, computer	10 KVA
Area, computer	540 sq ft
Room size, computer	18 ft x 30 ft
Floor loading	75 lbs/sq ft
Capacity, air conditioner	20 Tons
Weight, computer	10,200 lbs

Building air conditioning of 20 tons is sufficient. System only has built in fans. The ambient temperature is 78°F.

PRODUCTION RECORD

David Taylor Model Basin

Number produced to date	1
Number in current operation	1

One experimental model built.

COST, PRICE AND RENTAL RATES

David Taylor Model Basin

The central computer, drum unit, 3 magnetic tape units, and paper tape units cost $1,600,000.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

David Taylor Model Basin

The computer is being used on an experimental basis at this time.

ADDITIONAL FEATURES AND REMARKS

David Taylor Model Basin

The 100 different commands make the system powerful. Low memory cycle time for this type system. Easy to operate. Excellent for solution of problems involving a large amount of computation time.

INSTALLATIONS

U. S. Navy David Taylor Model Basin
Washington 7, D. C.

PROGRAMMED DATA PROCESSOR

Programmed Data Processor

MANUFACTURER

Digital Equipment Corporation

Photo by Digital Equipment Corporation

APPLICATIONS

System is designed for general purpose computing, on-line and real-time uses, on-line auxiliary to larger computers, and special applications requiring variety of input-output equipment and/or high operating speed.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	18
Binary digits/instruction	18
Instructions/word	1
Instructions decoded	25 basic, 53 incl. augmented
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-(2^{17}-1) \leqslant N \leqslant (2^{17}-1)$

Instruction word format

Instruction					Indirect	Memory Address, Y											
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

An advanced computer and other utility programs are being developed.

Registers and B-boxes include a memory buffer, an accumulator, an In-Out Register (and accum extension), a program counter and a memory address register.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	5	0.75
Mult	300 avg	300
Div	600 avg	600

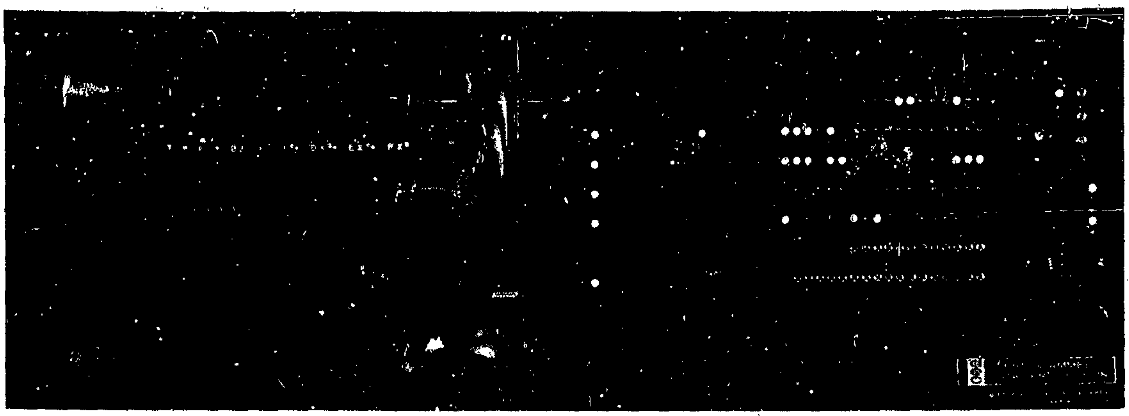


Photo by Digital Equipment Corporation

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

Multiply and Divide by subroutine augmented by Multiply Step and Divide Step instructions.

Normal input-output is promarily sequential. An optional in-out system allows concurrent operation of several in-out devices.

STORAGE

Media	No. of Words	No. of Digits/word	Access Microsec
Core	1024 or 4096	18	5 (cycle)

Additional memory banks may be added.

Magnetic Tape

No. of units that can be connected	64	Units
No. of chars/linear inch of tape	200	Chars/inch
Channels or tracks on tape	7	Tracks/tape
Blank tape separating each record	3/4	Inches
Tape speed	75	Inches/sec
Transfer rate	15,000	Chars/sec
Start time	3	Millisec
Stop time	3	Millisec
Physical properties of tape		
Width	1/2	Inches

INPUT

Media	Speed
Paper Tape Reader	300 char/sec
Typewriter	10 char/sec

Many optical input devices are available.

OUTPUT

Media	Speed
Paper Tape Punch	20 char/sec
Typewriter	10 char/sec
CRT Display	20,000 points/sec

Many optical output devices.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	3,000
Transistors	2,700
Magnetic Cores	73,728

CHECKING FEATURES

Overflow checks are included. The memory parity check system is optional.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.8 Kw
Volume, computer	70 cu ft
Volume, console table	84 cu ft
Area, computer	12 sq ft
Area, console table	21 sq ft
Room size	12 x 12 ft
Weight, computer	1600 lbs

Site preparation not required.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	1
Number on order	1
Time required for delivery	4 months

COST, PRICE AND RENTAL RATES

Computer, with 4096 word memory, typewriter, punch and photoelectric tape reader $110,000

Service contracts available.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

PDP-1 is built of DEC's standard line of reliable digital building blocks.

ADDITIONAL FEATURES AND REMARKS

The machine has an unusually high (>1) operations per second to initial cost ration. It is, thus, well suited to many real time control problems and is an excellent machine for interpetive programming.

Greater than 100,000 operations per second, flexible input-output, and powerful order code for a machine of this size.

FUTURE PLANS

A 36 bit version of this machine is being designed. The new Model (PDP-3) will multiply in 20 microseconds including memory access.

RASTAC

Random Access Storage and Control

MANUFACTURER

Laboratory for Electronics

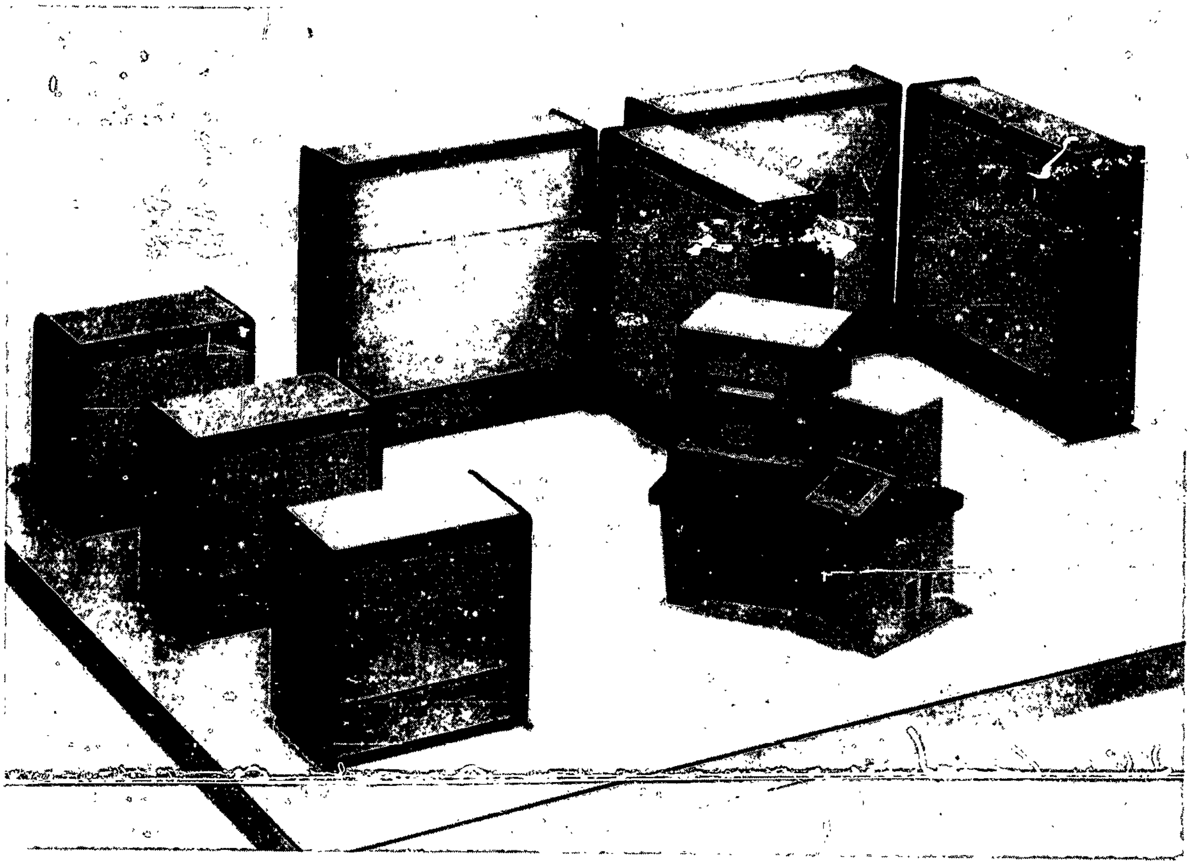


Photo by Photo International for Laboratory for Electronics, Inc.

APPLICATIONS

System is designed for mass information handling, providing integrated random access computer storage. RASTAC was developed to provide large scale digital computers with a random high speed data retrieval capability. Generally speaking, the storage media of most computers is not geared to the requirement for frequent access to segments of its file - the queueing problem tends to reduce the systems usage to that of an electronic file clerk. RASTAC permits considerably more access to information by the computer of an updating station and at the same time, leaves the computer free to perform its prime data processing functions.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Optional
Digits per word	Variable
Digits per instruction	12
Instructions per word	Variable
Instructions decoded	Two
Instruction type	One address, specifying beginning of transfer point

Instruction word format

12 Character Instruction

IM	TRACK	ADDRESS	SECTOR	NO OF SECTORS	OP	IM

IM = Instruction marker

OP = read or write operation

There are three registers, viz the I/O Register, the instruction register, and the track address register. The RASTAC System is designed to be operated with any large computer installation and therefore the choice of the number system or digits per word is entirely up to the option or the machine characteristics of the user. The only fixed word in this system is the 12 character instruction word.

This instruction word is coded in excess 3 decimal notation.

ARITHMETIC UNIT

No arithmetic unit as such

Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
HD File Drum	Variable	1875 to 62 million	197,000 av.

Up to 33 file drums can be included in the standard system giving a maximum of approximately 62 million characters. The access times given above include drum switching. The file drum rotates at 3 rps and recording is serial. Each file drum has a capacity of 15 x 10^6 bits. The average random access time to any part of the file remains constant, independent of the total number of drums. Each file drum unit contains its own reading and writing mechanism and track selection devices.

INPUT

Media	Speed
Keyboard (Alphanumeric)	Manual
Paper Tape	330 char/sec
From any Computer	20 kc character

The system is designed to work as an input-output device connected to a large computer; as such, its information transfer rate is 20 kc character rate.

OUTPUT

Medium	Speed
To any Computer	20 kc

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Use
Tubes	150	DC and pulse power drivers
Diodes	8,000	Primarily for logic
Transistors	100	Flip-flops and inverter switches
Magnetic Cores	2,000	Logical amplifiers and inverters

The system is composed of nine basic types of highly reliable magnetic modular building blocks, plus a small number of special plug-in counter packages. All packages are readily accessible as well as completely interchangeable within a given type.

CHECKING FEATURES

Operational errors which may occur during a read or write routine and parity errors of the paper tape input are detected. Errors are classified internally as critical or non-critical depending on their effect on information in the storage. Critical errors stop reading or writing instantly. Non-critical errors allow reading to continue to the end of the addressed information.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	13.3 Kw	15.3 KVA
Volume, Central System	300 cu ft	
Volume, File Drums (ea)	35 cu ft	
Area, Central System	48 sq ft	
Area, File Drums (ea)	9 sq ft	
Room size	25 x 30 ft	
Floor loading	200 lbs/sq ft	
	200 lbs concen max	
Weight, computer	3,200 lbs, total	
Weight, File Drums	800 lbs, each	

Clean atmosphere is desirable but not essential, inter-cabinet cables may be run in void beneath floor or in conduits as may be dictated by the site. 3 phase, 110-120v AC power is required.

PRODUCTION RECORD

Time required for delivery from receipt of order
8 months

COST, PRICE AND RENTAL RATES

Central System Controller	\$100,000 to \$300,000
File Drums	\$ 34,000 to \$ 38,000

Maintenance and service contracts are available and are customarily negotiated under separate contracts.

PERSONNEL REQUIREMENTS

Training is available to the users by the manufac turer. Since the RASTAC System is normally incorporated into a large computer complex the problem of deciding yhe typical personnel requirements are integrated with those of the large computer installation with maintenance and engineering service on a shared basis with the computer. The actual system users themselves are of many and varied types and need little instruction or operational abilities.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

A similar system, RASTAD has been in operation for a period of approximately 8 months. During this time, the reliability figures have shown a mean-time-to-failure of approximately 200 hours. The previously established reliability figures of the component board types used in the RASTAC System in conjunction with the circuitry technique, etc., have shown this to be a conservative figure.

ADDITIONAL FEATURES AND REMARKS

High capacity bulk storage with low access time, make the RASTAC System suited for integrated operation with a computer.

The unique advantage of the RASTAC System is the flexibility of the storage device. The storage capacity can be raised from the basic 15 million bits to 500 million bits with no change in random access time.

FUTURE PLANS

New developments at Laboratory for Electronics, are concentrated in two main fields with regard to the RASTAC System, that of additional output devices and of newer and better storage devices. In storage development, a new flexible Bernoulli Disk is being used to decrease the cost per list stored and the access times.

RASTAD

Random Access Storage and Display

MANUFACTURER

Laboratory for Electronics, Inc.

APPLICATIONS

System is designed for mass information handling. It can function as an integrated random access computer storage and display system and as an information storage and display unit for reference library techniques, such as management sales reports, status of operations, and inventory and production control. RASTAD was developed to provide large scale digital computers with a random, high speed, data retrieval capability. Generally speaking, the storage media of most computers is not geared to the requirement for frequent access to segments of its file - the queueing problem tends to reduce the systems usage to that of an electronic file clerk. RASTAD permits considerably more access to information by either the computer or the output display devices and at the same time, leaves the computer free to perform its prime data processing functions. Additionally, the output rate of the display devices provides data availability rate far in excess of that provided by the usual output devices.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Optional
Digits per word	Variable
Digits per instruction	12
Instructions per word	Variable
Instructions decoded	Two
Instruction type	One address, specifying beginning of transfer point

Instruction word format

12 Character Instruction

IM	TRACK	ADDRESS	SECTOR	NO OF SECTORS	OP	IM

IM = instruction marker
OP = Read or write operation

The RASTAD System is designed to be operated with any large computer installation and therefore the choice of the number system or digits per word is entirely up to the option or the machine characteristics of the user. The only fixed word in this system is the 12 character instruction word. This instruction word is coded in excess 3 decimal notation. There are three registers, the I/O register, the instruction register, and the track address register.

ARITHMETIC UNIT

No arithmetic unit as such

Timing	Synchronous
Operation	Sequential

Drums are asynchronous.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
HD File Drum	Variable	1875 to 62 million	197,000 av

Up to 33 file drums can be included in the standard system, giving a maximum of approximately 62 million characters. The access times given above include drum switching. The file drum rotates at 3 rps and recording is serial. Each file drum has a capability of 15 x 10^6 bits. The average random access time to any part of the file remains constant, independent of the total number of drums. Each file drum unit contains its own reading and writing mechanism and track slection devices.

INPUT

Media	Speed
Keyboard (Alphanumeric)	Manual
Paper Tape	330 char/sec
From any computer	20 kc char

The system is designed to work as an input-output device connected to a large computer; as such, its information transfer rate is 20 kc character rate.

OUTPUT

Medium	Speed	Remarks
SM-II Viewer System	20 kc	Direct View Storage Tube Device with instruction keyboard

The SM-II is a completely flexible output display device. The information displayed is stored on the face of the tube. This display may consist of a page of information or may take the form of a map, chart, graph or any abstract display desired. The total display capacity for the 21" Viewer is 13,000 characters. Storage time for a display is up to 20 minutes. This retention capability permits the superimposition of the pertinent data over an original display for a more complete evaluation at a single viewing.

Data retrieval and display is accomplished by pressing keys on a keyboard similar to an office calculator. The desired information is retrieved and displayed in less than 2 seconds after the start key is pressed (this occurs where only one viewer is used). Under more severe conditions where ten viewers were requesting information at the same moment, the waiting time for display of information on the lowest priority viewer would be less than 20 seconds.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Use
Tubes	150	DC and pulse power drivers
Diodes	8,000	Primarily for logic
Transistors	100	Flip-flops and inverter switches
Magnetic Cores	2,000	Logical amplifiers and inverters

The system is composed of nine basic types of highly reliable magnetic modular building blocks, plus a small number of special plug-in counter packages. All packages are readily accessible as well as completely interchangeable within a given type.

CHECKING FEATURES

Operational errors which may occur during a read or write routine and parity errors of the paper tape input are detected. Errors are classified internally as critical or non-critical depending on their effect on information in the storage. Critical errors stop reading or writing instantly. Non-critical errors allow reading to continue to the end of the addressed information.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	13.3 Kw	15.3 KVA
Volume, Central System		300 cu ft
Volume, File Drums (ea)		35 cu ft
Area, Central System		48 sq ft
Area, File Drums (ea)		9 sq ft
Room size		25 x 30 ft
Floor loading		200 lbs/sq ft
		200 lbs concen max
Weight, computer		3,200 lbs, total
Weight, File Drums		800 lbs, each

Clean atmosphere is desirable but not essential, inter-cabinet cables may be run in void beneath floor or in conduits as may be dictated by the site. 3 phase, 110-120v AC power is required.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	1
Time required for delivery	8 months

COST, PRICE AND RENTAL RATES

Central system controller	$100,000 to $[illegible]
File Drums	$ 34,000 to $ 38,000
Viewers, displays	$ 20,000 to $ 30,000
Additional equipment	
Viewers	$ 20,000 to $ 30,000
File Drums	$ 34,000 to $ 38,000

Maintenance and service contracts are available and are customarily negotiated under separate contract. Rental is negotiable.

PERSONNEL REQUIREMENTS

Training is available to the users by the manufacturer.

Since the RASTAD System is normally incorporated into a large computer complex the problem of deciding the typical personnel requirements are integrated with those of the large computer installation with maintenance and engineering service on a shared basis with the computer. The actual system users themselves are of many and varied types and need little instruction or operational abilities. The display units simply require a request and location of information and proceed from there automatically.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The RASTAD System has been in operation for a period of approximately 8 months. During this time, the reliability figures have shown a mean-time-to-failure of approximately 200 hours. The previously established reliability figures of the component board types used in the RASTAD System in conjunction with the circuitry techniques, etc., have shown this to be a conservative figure.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include high capacity bulk storage with very low access time, coupled with the ability to display large sections of information for long periods with minimum access to the files. The RASTAD System is suited for integrated operation with a computer.

The unique advantages of the RASTAD System is the extreme flexibility of the storage and display devices. The storage capacity can be raised from the basic 15 million bits to 500 million bits with no change in random access time. The display generation equipment allows an unlimited number of viewers to be driven from one symbol generator at speeds an order of magnitude greater than the fastest mechanical output devices. The characters displayed can be either alphanumeric or abstract symbols and can be changed in a matter of minutes.

The high output speeds of the display devices coupled with the access times of the central storage enable up to 100 output devices to be coupled with the RASTAD System before queueing times become a serious problem.

FUTURE PLANS

New developments at Laboratory for Electronics, are concentrated in two main fields with regard to the RASTAD System, that of additional output devices and of newer and better storage devices. With regard to the output of display devices, systems are being developed to enable wall displays for the briefing room applications of the integration of access systems for microfilm archival storage and systems for hard copy read out devices. In storage development a new flexible Bernoulli Disk is being used to decrease the cost per list stored and the access times. The access times of these disks will allow many hundred viewers to be coupled into one system without overload. New low cost types of viewers are being developed using stored video techniques for display recirculation.

RCA 110

RCA 110 Electronic Industrial Computer System

MANUFACTURER

Radio Corporation of America
Industrial Computer Systems Department

APPLICATIONS

The system is designed to perform industrial control functions, on-line in real-time. The RCA 110 was designed not as a "package" but as a total system - which can be tailored to the exact data control needs of each user.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary or binary coded decimal
Binary digits/word	24
Arithmetic system	Fixed point
Instruction type	One address

There is a limited two address feature. There are 71 wired-in instructions.
Registers include 7 indexable address modifier registers and 8 high speed input-output registers.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	56
Mult	728
Div	868

Timing Synchronous
Word time is 28.89 microseconds. Clock frequency is 936 kilocycles/sec.

STORAGE

Media	No. of Words	Access Microsec
Magnetic Core	256 to 4,096	
Magnetic Drum	4,096 to 51,200	8,300 avg.

Drum transfer rate is 200 kilocycles/sec. Up to 12 buffer tracks are available for input-output.

INPUT OUTPUT

Industrial control

CHECKING FEATURES

Computer free time is automatically assigned to self checking routines.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	5.0 KVA	220 Volts
Size, computer	82 x 34 x 105 inches	

ADDITIONAL FEATURES AND REMARKS

The system automatically responds to off-limit or emergency situations and handles them on a priority basis with a complete analysis of priority after each instruction. This eliminates the delay between the occurrence and the recognition of an emergency condition. The system will correct the most urgent situation first, but if more than one trouble-spot should occur at the same time, it automatically appraises the urgency of each and handles it in turn.

INSTALLATIONS

Radio Corporation of America
Industrial Computer Systems Department
Electronic Data Processing Division
21 Strathmore Road
Natick, Massachusetts

RCA 200

RCA Series 200 Guidance Computer

MANUFACTURER

Radio Corporation of America
Missile Electronics and Controls Division

APPLICATIONS

Interial navigation and guidance digital differential analyzer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20
Arithmetic system	Twos complement
Instruction type	

Single instruction - integrate; coding specifies integrator interconnections.

Number range $-1 \leq N < +1$

Instruction word format

ΔY Address	Y Register	Mem. Plane 0
		Mem. Plane 1
ΔX Address	R Register	Mem. Plane 2
		Mem. Plane 3

Programming capability consists of selecting up to 12ΔZ's as components of $Z\Delta Y$, selecting a ΔZ to be used as ΔX, and specifying lengths of Y and R registers.

ARITHMETIC UNIT

Time for processing one integrator is 850 microseconds.

Construction (Arithmetic unit only)

Transistors	1,500
Diodes	300
Magnetic cores	1,024
Other components	2,100
Arithmetic mode	Serial
Timing	Asynchronous
Operation	Arithmetic unit is serial, operating on 2 bits at a time. Computer is a digital differential analyzer.

STORAGE

Medium	No. of Words	No. of Digits
Coincident Current Core Memory	16 integrators	20 bits/ integrators

INPUT OUTPUT

Input consists of error signal in accelerometer control loop; computer converts this signal to digital form in conjunction with a digital velocity meter. The computer is part of the accelerometer control loop.

Core memory is loaded with a photoelectric reading head, through which a 25" length paper tape is pulled by hand.

Output consists of increments of desired quantities, which are used to drive stepping motors.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	300 Zener diodes

Zener diodes to be replaced by resistors in subsequent models.

Transistors	1,500

Types 2N404 and 2N357

Magnetic cores	1,024

CHECKING FEATURES

All checking is performed through programming. A pluggable checkout panel is used to display all important computer signals as an aid to programmer checkout.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.02 Kw
Volume, computer	0.06 cu ft
Weight, computer	4.5 lbs

Power, space and weight specifications are for micromodular version.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System has been operating for over 3 months and is about to go on flight test.

FUTURE PLANS

System to be micromodularized in early 1961. Present operating version contains "mini-modules", having the two base dimensions the same as those of RCA's micromodule, but with a height of 1 to 2 inches, depending on the module.

RCA 300

RCA Series 300 Central Computer

MANUFACTURER

Radio Corporation of America
Missile Electronics and Controls Division

APPLICATIONS

Real time control, airborne and shipboard applications (guidance, navigation, fire control, etc.); sensor signal data processing, air or shipboard (trajectory analysis, target keeping, etc.); and missile-space applications - guidance, on-board checkout, data reduction, etc.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	13
Binary digits/instruction	13
Instructions/word	1
Instructions decoded	33
Arithmetic system	Fixed point
Instruction type	One address
Instruction word format	

Sign	1 3	4	5 12
	Command	B Box	Operand Address

All input and all output proceeds automatically upon recognition of "Start Input/Output" instruction. There is one B-Box of 8 bits. Modular nature of parallel machine permits word length to suit problem.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	24	12
Mult	96	86
Div	168	156

Construction (Arithmetic unit only)	
Transistors	1,418
Diodes	518
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Transfluxors	8,192 max.	106,300	3
Cores	1,024 max.	13,330	4

Transfluxors are used in non-destructive read-out mode for program storage; cores are used for data storage.

INPUT

Media	Speed
Tape Reader	20 char/sec
Voltage Analog-to-Digital Con	50,000 bits/sec
Direct Digital	41,667 words/sec

The tape reader loads programs only. There are 3 A-D converter channels in prototype. Up to 32 are available. Up to 32 words of direct digital inputs (from shaft of A-D converters, etc.) can be accepted.

OUTPUT

Media	Speed
Flexowriter	10 char/sec
Analog/Digital Conversion	41,667 words/sec
Direct Digital	41,667 words/sec

Up to 32 channels of A-D conversion are available. 5 channels are operative in the prototype. The direct digital output is used for discrete control of external devices.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
S4096	1,346
65003	64
65100	670
65309	212
Transistors	
2N357	1,692
2N404	3,708

Above counts are for a configuration consisting of 1,024 words transfluxor memory, 1,024 words core memory, 18 analog input words, and 18 analog output words.

CHECKING FEATURES

Checking is accomplished by repeat programming.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.135 Kw
Volume, computer	3.0 cu ft
Weight, computer	100 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	12 months

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Computer operating in laboratory for over twelve months.

ADDITIONAL FEATURES AND REMARKS

Outstanding feature is the transfluxor memory.

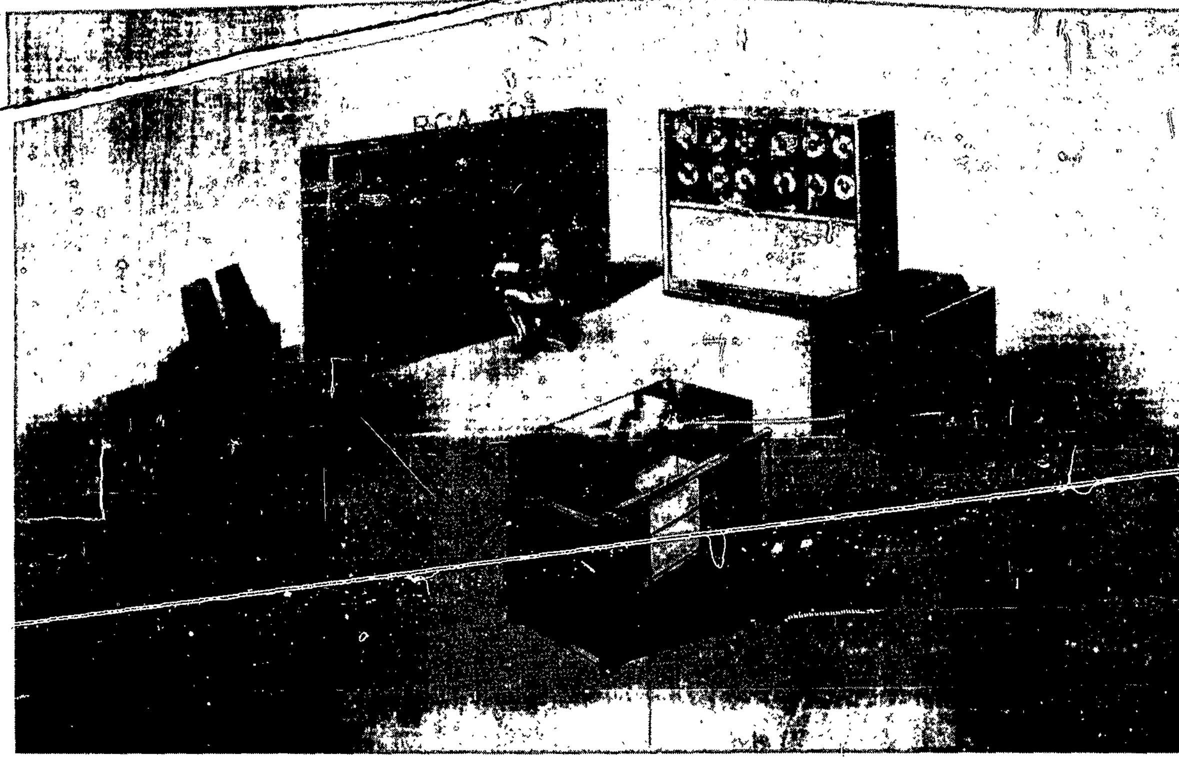
INSTALLATIONS

Radio Corporation of America
Missile Electronics and Controls Division
Burlington, Massachusetts

RCA 301
Radio Corporation of America 301

MANUFACTURER

Radio Corporation of America
Electronic Data Processing Division



Picture by Radio Corporation of America

APPLICATIONS

The computer is a general purpose, digital, stored program, transistorized machine consisting of high speed storage, program control, a control panel, and a power supply.

The program control unit contains circuitry for the interpretation and execution of the instructions. The high-speed storage unit is a magnetic core, decimally addressed, random-access device which provides the storage for data and programs. Memory cycle time is 7 microseconds. The basic unit contains 10,000 or 20,000 alphanumeric characters. The control panel contains the controls and indicators necessary for the operation and maintenance of the computer.

The power supply unit supplies power for operation of the control panel, the high-speed storage, and the program control, and standard voltages for the control of the input-output equipment. Transistor and diode logic techniques are employed throughout the system.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Number of binary coded decimal digits per word	Variable
Number of characters per instruction	10 RCA 301 characters
Number of instructions per word	Variable
Number of instructions decoded	40
Arithmetic system	Fixed point Programmed Floating point
Instruction type	Two-address
Number range	Limited by size of memory
Instruction word format	

1	1	4	4
Operation Code	N Character	A Address	B Address

Automatic coding RCA Narrator - COBOL (COmmon Business Oriented Language)

A variety of general-purpose service programs are provided. These include distribution-sorting, trace, memory dump, on-line input-output service routines, the RCA 301 Interpretar and the RCA 301 COBOL Narrator.

ARITHMETIC UNIT

	Microseconds
Add time (decimal), including instruction acquisition	210
Programmed multiply time, average	7,800
Transfer instruction	126
Compare	56 to 161
Basic cycle time	7
Arithmetic mode	Serial
Timing	Synchronous
Operation	Concurrent

Above times assumes 6-character fields.

Multiply time assumes average multiplier digit is 5.

STORAGE

Media	No. of Char.	Access Microsec
Magnetic Core	20,000	7
Record File	Over 4.6×10^6, each	4.25×10^6

The number of words of storage is variable due to variable word length. The Record File is random access. Up to 5 files may be used. Access to files is simultaneous.

Magnetic Tape — Hi Data tape

Type 580 Tape Station, with Tape Adaptor, records 222 char/inch at 100 inches/sec. The type 581 Tape Station, with Tape Adaptor, records at 333 char/inch at 100 inches/sec.

No. of units that can be connected	12 Units
No. of chars per linear inch of tape	250 Chars/in
Channels or tracks on the tape	1 Track/tape
Blank tape separating each record	Inter-Block gaps = approx. one inch
Tape speed	30 Inch/sec
Transfer rate	7,500 Chars/sec
Start time	Up to 20 Millisec
Stop time	Not exactly established (overlaps computation)
Average time for experienced operator to change reel	45 Seconds
Physical properties of tape	
Width	1/2 Inches
Length of reel	1,200 Feet
Composition	Mylar

INPUT

Media	Speed
Punched Paper Tape	100 chars/sec
Punched Cards	600 cards/min
Magnetic Tape	See Magnetic Tape
Record File	2,500 char/sec (transfer rate)

OUTPUT

Media	Speed
Punched Paper Tape	100 char/sec
Punched Cards	100 cards/min
Magnetic Tape	See Magnetic Tape
Record File	2,500 char/sec (transfer rate)
Hi-Speed Printer	600 lines/min (120 char/line)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Types

Transistors

3656

[illegible]580

Diodes

85106/4-D3

Quantity depends on system.

CHECKING FEATURES

Accuracy control is accomplished on the RCA 301 system by the following methods:

Processor, Models No. 303 and No. 304

Program Control

The following conditions will stop computer operations:

- Incorrect parity in memory address register
- Incorrect parity in memory register
- Incorrect parity in operation register
- Incorrect parity in N register
- Incorrect parity in N R (repeat) register

Input/Output

Any of the following conditions will stop computer operation:

- Device not operable or not responding to applicable computer command
- Parity error in data received from input device
- Non-verification of data sent to an output device

Paper Tape Reader - Punch Control - Model No. 311

The computer is caused to stop whenever any of the following conditions occur:

- Failure to receive the write-verify pulse
- Incorrect parity of information being read
- Characters in a gap space
- Reader not following command
- Punch not following command

Card Reader Control - Model No. 314

The card is read at two stations and a hole count check is made. An error will stop the computer, and the Card Reader.

Punch Card Control - Model No. 315

The cards are automatically read after punching.

On-Line Printer Control - Model No. 316

Signals are returned to the printer control module from the On-Line Printer, so that corrective measures can be taken whenever any of the following conditions occur:

Low paper supply
Ribbon failure
Printer motors off
Power supply off

Record File Control - Model No. 317

Any of the following conditions will cause the computer to stop:

Incorrect parity of address sent to Record File
Non-verified write information
Record file not following command
Incorrect parity of information being read

Hi-Data Tape Group Control - Models No. 318 and No. 319

Monitors the write-verify check, the address-verify parity check, the operability, and the response to commands of the Hi-Data Tape Group.

Paper Tape Reader-Punch - Model No. 321

The information received at the punch is checked; and when parity is correct, a write verify pulse is returned to the Paper Tape Reader-Punch Control.

Card Reader - Model No. 323

Each card is read twice to permit an accuracy check.

On-Line Printer - Model No. 333

Signals are sent to the Computer so that corrective measures may be taken which cause the Printer-operation to stop whenever any of the following conditions occur:

Low paper supply
Ribbon failure
Printer motor off
Printer in non-operable condition

Card Punch - Model No. 334

The cards are read after punching to permit an accuracy check of the punched data.

Record File - Model No. 361

Parity check is performed on the information to be written and on the address received from the Record File Control for the selection of records.

Hi-Data Tape Group - Model No. 381

Automatic stop of tape at end of reel
Write lockout
Write verify
Address verify
Operable indication

Record File Mode Control - Model No. 391

Parity checks of data and address are performed.

Simultaneous Mode Control - Model No. 392

Parity checks are performed on SOR and M registers. An error will stop the computer. However, the other modes will complete their operation before they stop.

580/581 Adaptor - Model No. 393

The write-verify pulse is received when the head-write current is of correct parity. Operability and response to commands are also checked.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Estimated Area (Average System)

Data Processing Equipment Area	825 sq ft
Additional Area Consumed by Aisles, Exits, structural columns and unusable corners	425 sq ft
Engineering Service	300 sq ft
	1,550 sq ft

Above estimate does not include any space for Analysis, Programming Personnel, Magnetic Tape Reel Library, Operating Supplies, Air Distribution or Power Equipment.

Estimated Power	KW	KVA
Data Processing Equipment	25.9	32.2
Engineering Service Requirement	3.5	4.5
	29.4	36.7

Above power requirement should be 208V, 4-wire system at a constant voltage to insure proper power for the equipment, and does not include any power requirements for the computer system and engineering service area.

Estimated Cooling	Tons
Data Processing Equipment Requirement	8.4
Engineering Service Equipment Requirement	1.0
	9.4

The above cooling is based on the requirement to remove the heat dissipated by the equipment. This equipment will give satisfactory operation in an environment of 72 degrees F temp. and 50% relative humidity.

Estimated Floor Loading

The installed RCA equipment can be placed on a floor which will support a loading of 100 lbs/sq ft. Most office buildings have floors that meet this loading requirement.

It must be understood that above estimates are not to be considered complete or final in any respect. Final specifications on power, cooling and floor loading will be issued.

Site Preparation

The layout and installation are very flexible. Site preparation is a customer responsibility normally accomplished by electrical, mechanical and structural contractors employed by the customer in arrangements that are not part of the EDP equipment purchase lease or service.

State and local laws and regulations require that a professional engineer or architect take responsibility for preparation of the site and procurement of necessary permits.

PRODUCTION RECORD

Prototype under construction
Time required for delivery from receipt of order
18 months

COST, PRICE AND RENTAL RATES

RCA 301 Card System

Qty	Item	Selling Price	Basic Monthly Rental
1	623 Card Reader	$ 15,850	$ 350
1	314 Card Reader Control	6,900	130
1	634 Card Punch	8,900	200
1	315 Card Punch Control	13,750	275
1	361 Record File	14,900	300
1	317 Record File Control	6,250	125
1	632 On-Line Printer	32,200	700
1	316 On-Line Printer Control	7,850	150
1	303 Basic Processor (10,000 char.)	89,400	1,750
	Total	$ 196,000	$ 3,980

RCA 301 System and Components

Qty	Item	Selling Price	Basic Monthly Rental
1	301 Basic Processor with 20,000 characters of core storage	$ 112,900	$ 2,350
1	321 Paper Tape Reader/Punch (100 char/sec)	7,800	170
1	311 Paper Tape Control	5,900	120
1	381 HiData Tape Group (6 tape stations 7,500 char/sec)	74,900	1,520
1	318 Hi Data Control	17,900	375
1	391 Record File Mode Control (Permits simultaneous operation of up to five Record Files)	32,800	690
1	329 Simultaneous Mode Control (Permits simultaneous read-write and under some conditions read-write-compute)	27,900	590
1	393 Tape Station Adaptor (Permits use of 22,222 or 33,333 char/sec tape stations)	15,900	320

Equipment lease and service agreements available

PERSONNEL REQUIREMENTS

Typical Personnel Required per Shift

	One 8-Hour Shift	Two 8-Hour Shift	Three 8-Hour Shift
Supervisors	1	1	1
Analysts	*	*	*
Programmers	*	*	*
Coders	*	*	*
Clerks	0.5	0.5	0.5
Librarians	0.5	0.5	0.5
Operators	2	1	1
Engineers	0	0	0
Technicians	0	0	0
In-Output Oper	0.5	0.5	0.5
Tape Handlers	0.5-1.5	0.5-1.5	0.5-1.5
Totals	10	7	6

The number of persons working in an RCA 301 EDP center is dependent upon the work and complexity activity of the system.

*If it is desired to accelerate the system development and programming, this area should be augmented until the initial peak is overcome.

Training made available by manufacturer to users:

RCA offers, without charge, courses in the application and use of the RCA 301 Transistorized EDP System equipment. RCA will provide training of personnel or representatives of the users in the analysis of data processing tasks to be assigned to the equipment, in the development of procedural systems and of computer programs, and in the revision and correction of the procedures and programs developed by trainees.

This training of analysts will be performed at mutually agreed upon locations beginning 15 days after selection of equipment. A continuous education program is also available to prospective users.

ADDITIONAL FEATURES AND REMARKS

Features include:

a. Variable item and record length
b. Building block concept
c. Large internal magnetic core storage for its size
d. Random access file
e. Low installation cost

System advantages are:

In addition to the library, RCA provides the customer with an Automatic Assembly System designed to simplify and therefore expedite the writing of programs.

The system is "machine oriented", i.e., its format is designed to accept instructions closely analogous to actual machine instructions.

English language programming (COBOL) will be available to users of this equipment.

FUTURE PLANS

RCA continues electronic research in support of this system.

INSTALLATIONS

U. S. Navy Administrative Office, EXOS, AO, EAD, EDPB, Washington 25, D. C.

RCA 501

Radio Corporation of America 501

MANUFACTURER

Radio Corporation of America
Electronic Data Processing Division

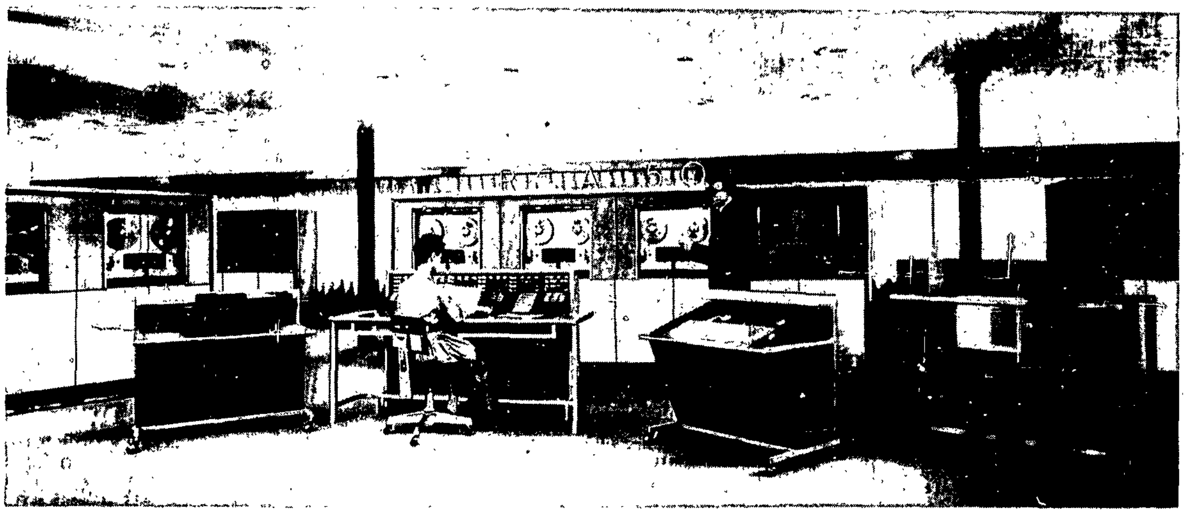


Photo by Radio Corporation of America

APPLICATIONS

Manufacturer

A general purpose, self checking, readily expandable system in the intermediate and large-scale performance class. The system design uses the "building-block" philosophy which results in an expandable, flexible integrated data processing operation, which can be tailored to the customer's needs at the time of delivery and expanded whenever future needs require it. The system may include both on-line and off-line input and output devices in addition to the Computer with High-Speed Storage. On-line equipments are electrically connected to the Computer and are controlled by the Computer Program. Off-line equipments are not electrically connected to the Computer and they are operated independently of the latter. Both on-line and batch data-processing are available in the System.

U.S. Naval Propellant Plant

The NPP system located in Bldg. 749 (JATO Test Area), Naval Propellant Plant will be an ordinary five-tape digital computer system which will be used with an Automatic Data Acquisition System on-line to monitor firings of solid propellant rocket motors and to calculate immediate quick-look parameters to indicate to monitoring personnel corrective action required. All applications of the computer will be strictly scientific. It will be used to compute theoretical specific impulse, experimental specific impulse from ballistic firings, heat transfer, and burning rate. The tapes to be used in on-line firings are non-gap type.

Scott Air Force Base

Located in Building 1604 at Scott AFB, Illinois, the system is used for traffic control, personnel, traffic analysis, manpower authorization accounting, programmed communications, unit authorization list, and circuit directory.

Air Reserve Records Center

Located at 3800 York Street, Denver 5, Colorado, the system is used for maintenance of personnel data on USAF reservists, preparing statistical reports reflecting the reserve military personnel strengths and skills, controlling military reserve manpower requirements and allocation of skills in the event of mobilization, preparation and control of questionnaires sent to individual reservists and to the Selective Service Boards, control of the Reserve Officer Promotion Act promotion program, preparation of mailing labels for periodicals, preparation of rosters for personnel assignment control, and determination of those eligible for discharge and preparation of applicable discharge certificates.

Fidelity-Philadelphia Trust Company

Located at 135 S. Broad Street, Philadelphia, the system is now processing 42,000 Special Checking Accounts. On July 1, 1960 accounting for 30,000 Personal Loans will begin. Cut-over of 50,000 Regular Checking Accounts will begin late this year with completion planned during the first half of 1961.

General Tire and Rubber Company

Located in Akron, Ohio, the system is used for

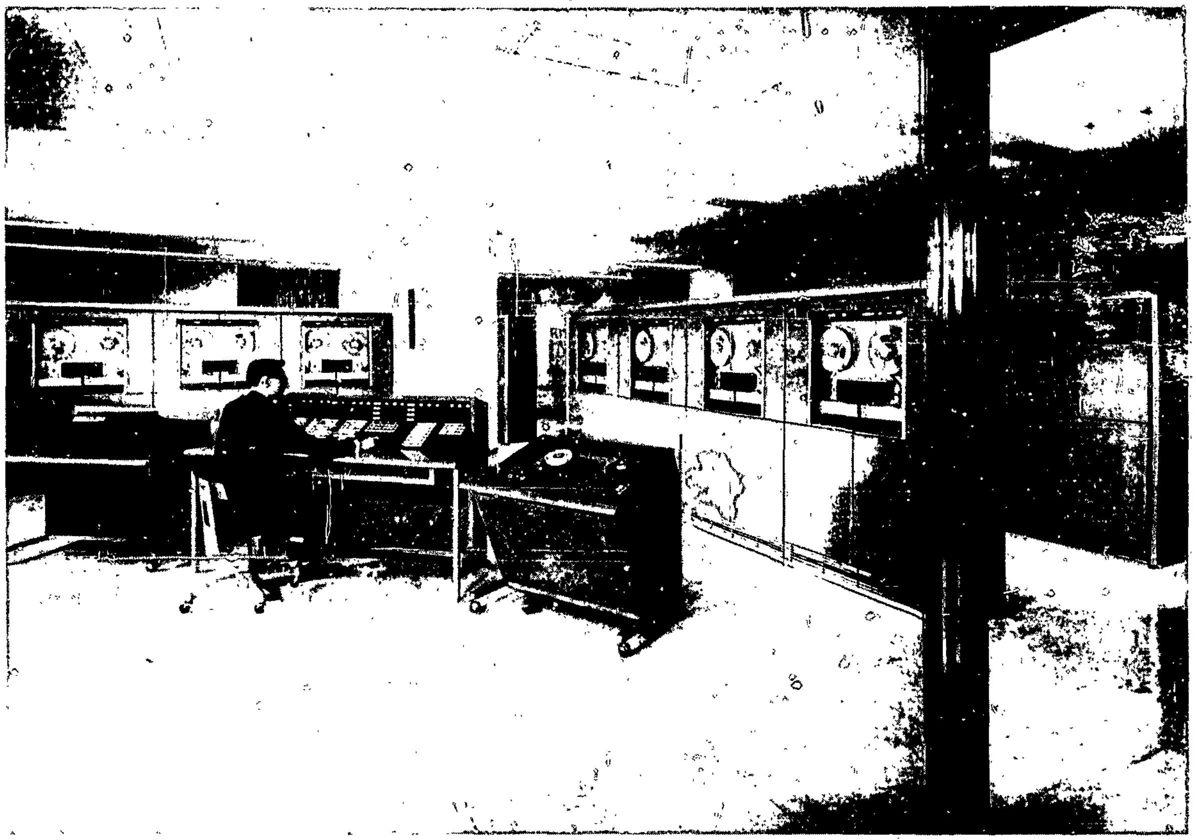


Photo by Fidelity-Philadelphia Trust Company

billing, inventory control, sales analysis, and accounts receivable within the Tire Division.

State Farm Life Insurance Company

Located on the 9th Floor at 112 East Washington Street, Bloomington, Ill., the system is used for consolidated records of life insurance policyholders for purposes of premium billing and accounting, policy reserve and dividend liability, policy termination benefits, policy loans, summary accounting and statistics, agents' compensation and production statistics, budget setting and compliance reports, unit costs, and actuarial studies.

Electronic Data Processing Division, RCA

Located at Camden, N.J., the computer is used for justification of engineering change notices, providing technical information for changes in the field, customer reliability studies, testing of special features resulting from configuration modifications, develop long term maintenance techniques, procedures and techniques, analysis of methods costs, and debugging service routines, diagnostic routines, and customer reliability routines.

RCA Electronic Systems Center

Located at the Cherry Hill Plant, RCA Electronic Systems Center, Merchantville, N.J., the system is used for customer program testing (preparatory to customers receipt of leased or purchased system), presentations (demonstration for potential customers), training (RCA and customer personnel in programming and operation), and revenue work (data processing for customers not presently in the market for data processing equipment of their own).

RCA Service Company-Electronic Data Processing Sales Department

Located at 1725 "K" Street, N.W., Washington 6, D.C., the system is used for sales demonstrations, debugging, and computing and calculating operations for governmental agencies, commercial and industrial business organizations.

EDPD-New York Electronics System Center

Located at 45 Wall Street, New York, N.Y., the system is used for a complete back office data processing system for brokerage firms, national election predictions, and investment analysis for investment advisory firms.

RCA Astro Electronics Division

Located at Locust Corners, N.J., the system is used for scientific and engineering investigations, information retrieval, intelligence processing studies, and electronic production schedules.

RCA Service Company, EDP Administration

Located at Cherry Hill, Camden 8, N.J., the system is used to conduct theoretical and practical courses in the site utilization of electronic test equipment for the maintenance of computer installations, devise special methods whereby sub-moduals are tested in order for instructors and trainees to develop new test methods for the computer and peripheral

Two RCA 501 Systems   Photo by New York Electronic Systems Center

equipment, and conduct computer courses of instruction to develop trainees ability to interrogate the logic of the equipment.

Ordnance Weapons Command

Located at the Headquarters, Ordnance Weapons Command, Rock Island, Ill., the system is used by the National Inventory Control Point for supply management of Ordnance materiel, major weapon components and spare parts, by the Production Equipment Agency for inventory management of Army owned production equipment, by the Rock Island Ordnance Depot for stock accounting, by the Rock Island Arsenal for production, planning, scheduling, and control and the performance of reporting and comptroller activities and by the NICP for cataloging.

Atlantic City Electric Company

The system, located at Accounting and Data Processing Center, Egg Harbor Township, N.J., is used for Customers Accounting - includes preparation of bills and centralized receivable operation, Payroll-includes all normal payroll functions and labor and automotive cost distribution, and Stores Accounting-includes maintenance of master files of material and supplies, pricing of material used, application of overheads and cost distribution of material and supplies consumed. Other applications will follow.

Ordnance Ammunition Command

Located at the Ordnance Ammunition Command, Joliet, Ill., the system is used for scientific and engineering applications pertinent to the reliability assurance program for ammunition and special weapons.

Raytheon Company - Missile Systems Division

Located at the Raytheon Company, Andover Plant, Andover, Mass., the system is used for engineering documentati n, generation breakdown and parts list, with changes, and for major item repair parts list provisioning.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary
Binary digits/word	Variable
Characters/instruction	8 (Octal equivalent)
Instructions/word	Variable
Instructions decoded	49
Arithmetic system	Fixed point (Programming techniques make floating point features available
Instruction type	Two address
Number range	No limit (Depends on number of characters in the memory)

Instruction word format

X	XXX	X	XXX
Op Code	"A" Address	N Char	"B" Address

Automatic coding	Automatic Assembler RCA Narrator (COBOL)
Registers and B-boxes	Included

Decimal information is automatically decoded during input to its octal equivalent. It is stored in memory in binary form.

ARITHMETIC UNIT

Manufacturer

Due to variable word length feature, time depends on "n". Storage access is 15 microseconds for 4 characters.

All time is in microseconds.

Addition Time

Decimal $15n_1 + 45n_2 + 30n_3 + 90$

Binary $45n$

where

n_1 = total number of spaces and/or minus characters found to the right of both operands

n_2 = number of digits in the shorter operand

n_3 = difference in number of digits of the operands

For negative sums, add $30(n + 1) + 15$ where n = number of digits in the sum.

n = number of characters in augend for binary addition

Multiplication Time (Microseconds)

Decimal $15\left[10 + (12n_1 + 32) n_2\right] + 15n_3$, for $n_1 > 0$ and $n_2 > 0$

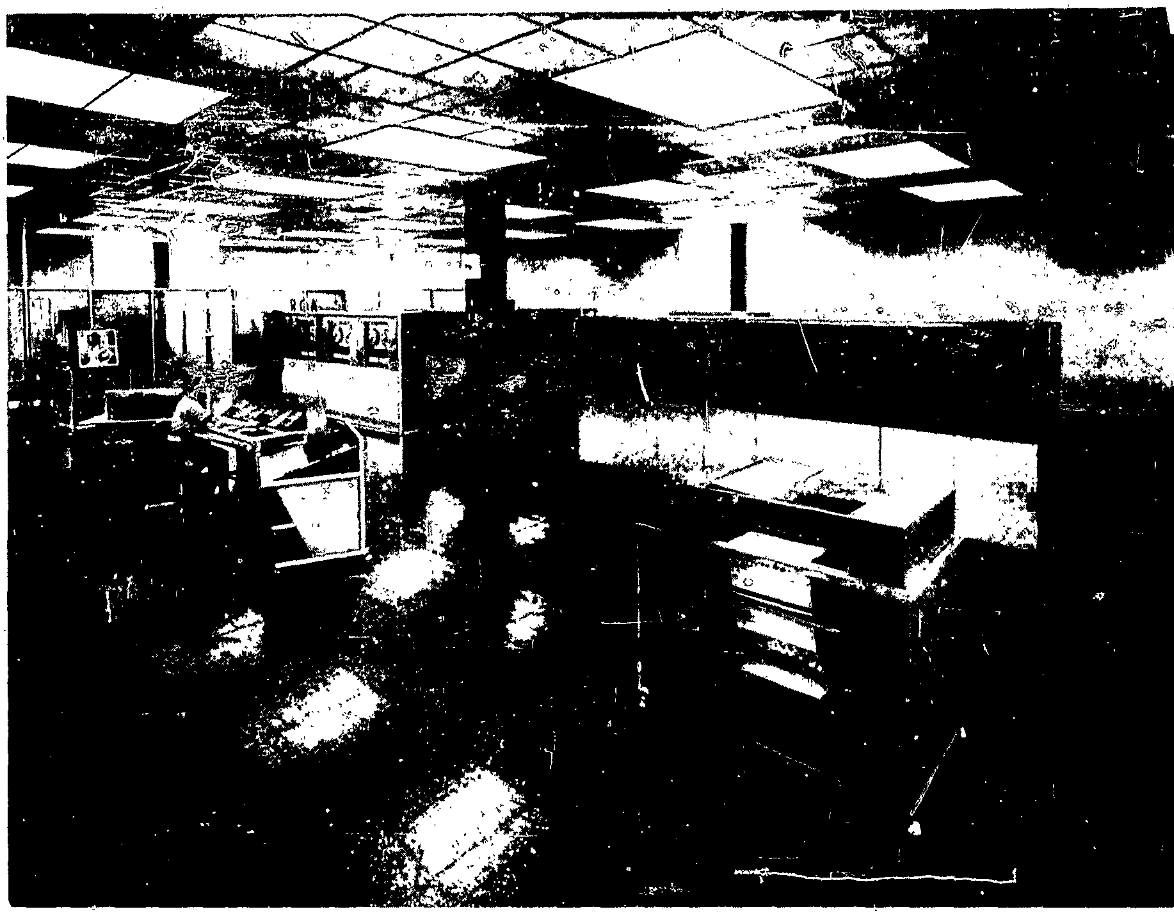


Photo by Atlantic City Electric Company

$15\ (n_2 + n_3 + 3)$, for
$n_1 = 0$ and $n_2 > 0$

$15\ (n_1 + n_3 + 3)$, for
$n_2 = 0$ and $n_1 > 0$

$15\ (n_3 + 3)$, for
$n_1 = 0$ and $n_2 = 0$ (Item Separator Symbol alone or all spaces plus I.S.S.)

where
n_1 = number of digits in multiplicand
n_2 = number of digits in multiplier
n_3 = total number of spaces (including sign) and/or minuses to the right of the least significant digits of the operands

Division Time (Microseconds)

Decimal $15\left[26n_1 - 7n_2 + 15n_2(n_1-n_2)+41\right] + 15n_3$
for $n_1 \geq n_2$

$15\ (3n_1 + n_2 + 12) + 15n_3$ for
$n_1 < n_2$

$15\ (n_2 + 7) + 15n_3$, for
$n_1 = 0$ (i.e., the dividend missing)

where
n_1 = number of digits in the dividend
n_2 = number of digits in the divisor
n_3 = total number of spaces (including sign) and/or minuses to the right of the least significant digits of the operands

The figures below serve to indicate general relative speed. For a specific case the formulas can be applied (Microseconds).

Add	240	to	420
Multiply	1,900	to	9,600
Divide	1,300	to	2,400

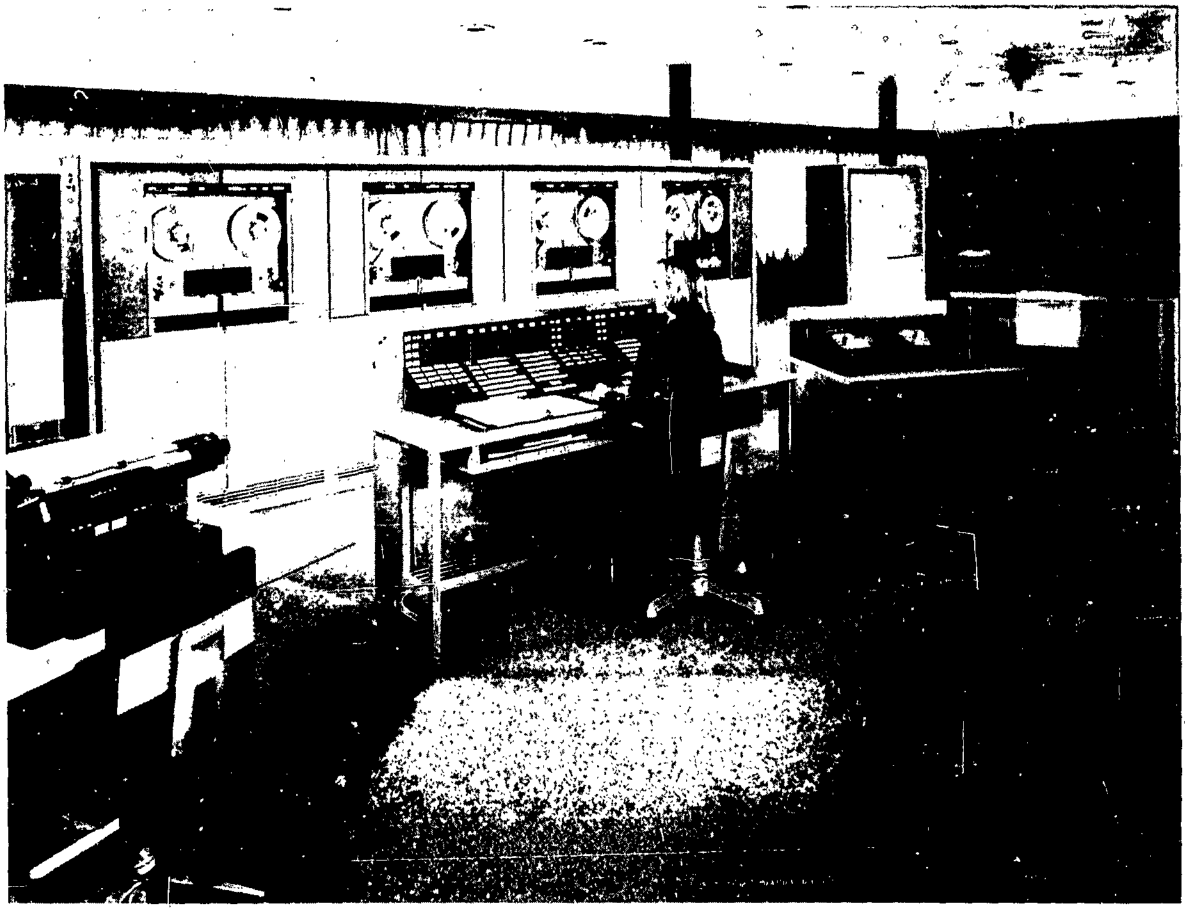


Photo by U.S. Army Ordnance Ammunition Command

Construction

Transistors	135	
Diodes	400	
Magnetic Cores	4,096	(one matrix)
Magnetic Cores	114,688	(one module)
No tubes are used		
Arithmetic mode	Serial	
Timing	Synchronous	
Operation	Concurrent	

Operands may be any length that does not exceed memory size.

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	Variable	262,144 (max)	15 (4-char)

Magnetic Tape

No. of units that can be connected	62	Units
No. of chars/linear inch	333.33	Chars/inch
Channels or tracks on the tape	16	Tracks/tape
Blank tape separating each record	0.34	Inches
Tape speed	Approx 100	Inches/sec
Transfer rate	22,222 33,333 66,666	Chars/sec
Start time	3.5	Millisec
Stop time	2.5	Millisec
Average time for experienced operator to change reel	45	sec or less
Physical properties of tape		
Width	3/4	Inches
Length of reel	2,400	Feet
Composition	Mylar	Base

U.S. Naval Propellant Plant

Medium	No. of Chars	Access Microsec
Magnetic Core	32,768 chars or 65,536 octal digits	15 microsec/ char

The magnetic core memory can be expanded to 262,144 locations. A random access drum with 1.5 million characters is optional equipment. In certain instructions, four characters may be brought out in parallel with a total access time of 15 microseconds, i.e. 15/4 microseconds per character. There is no "word" concept in this computer. It is a variable word length computer.

Scott Air Force Base

Medium	No. of Chars	Access Microsec
Magnetic Core	16,384	15

Photo by Raytheon Manufacturing Company

Mitchel Air Force Base

Medium	No. of Chars	Access Microsec
Magnetic Core	32,768	15

Expandable from 16,384 to 65,536 character locations in steps of 16,384 character locations.

Fidelity-Philadelphia Trust Company

Media	No. of Char	Access Microsec
Magnetic Core	16,384	15
Magnetic Tapes	9,000,000 per reel	30

General Tire and Rubber Company

Medium	No. of Char	Access Microsec
Magnetic Core	65,152	15

State Farm Life Insurance Company

Medium	No. of Char	Access Microsec
Magnetic Core	49,152	15

Electronic Data Processing Division, RCA

Medium	No. of Char	Access Microsec
Magnetic Core	65,536	15

EDPD - New York Electronics System Center

Medium	No. of Char	Access Microsec
Core	65,536	15

RCA Astro Electronics Division

Media
Random Access File
High Speed Storage (Core Memory)

RCA Service Company, EDP Administration

Medium	No. of Char
Magnetic Core	Variable

Ordnance Weapons Command

Media	No. of Char	Access Microsec
Magnetic Tape	65,536	15

Magnetic tape for bulk storage.

Atlantic City Electric Company

Media	No. of Char	Access Microsec
Magnetic Core	16,384	15
Magnetic Tape	9,400,000	30

Reading from tape potentially simultaneous operation

Ordnance Ammunition Command

Medium	No. of Char	Access Microsec
Magnetic Core Type	32,768	15

Raytheon Company - Missile Systems Division

Medium	No. of Char	Access Microsec
Magnetic Core Memory	32,968	15

Octal numbering system makes this memory comparable to systems with much larger memory capacities.

Photo by Air Reserve Records Center

INPUT

Manufacturer

Media	Speed
Paper Tape (Read)	Approx 1,000 char/sec
Magnetic Tape	22,222 33,333 66,666 char/sec
File Control	Approx 18,700 char/sec
On-Line Card Buffer	Up to 33,333 char/sec

U.S. Naval Propellant Plant

Paper Tape	1,000 char/sec
Magnetic Tape	33,333 char/sec

Speeds of 22 KC or 66KC are other options.

Magnetic tape start-stop time is 3.5 milliseconds. Up to 62 magnetic tape stations can be connected on-line. Information is recorded twice on the magnetic tape for accuracy control purposes.

Scott Air Force Base

Paper Tape	1,000 char/sec
Magnetic Tape	33,000 char/sec

Mitchel Air Force Base

Paper Tape (7 channel) 1,000 char/sec
On-line equipment
Magnetic Tape 33,000 char/sec
2300' usable tape per reel
Cards 400 cards/min
Off-line transcription
Punched paper tape density is 10 char/in.
Magnetic tape density is 333 1/3 char/in.

Fidelity-Philadelphia Trust Company

Media	Speed
Punched Paper Tape	1,000 char/sec

Add Punches have been greatly improved by refinements made recently by the manufacturer (Friden).

General Tire and Rubber Company

Paper Tape 1,000 char/sec
Speed excludes time required to pass gaps.

State Farm Life Insurance Company

Magnetic Tape (8)	33,333 char/sec
Paper Tape (1)	1,000 char/sec

Electronic Data Processing Division, RCA

Paper Tape	1,000 char/sec
Magnetic Tape	33 KC

RCA Electronic Systems Center

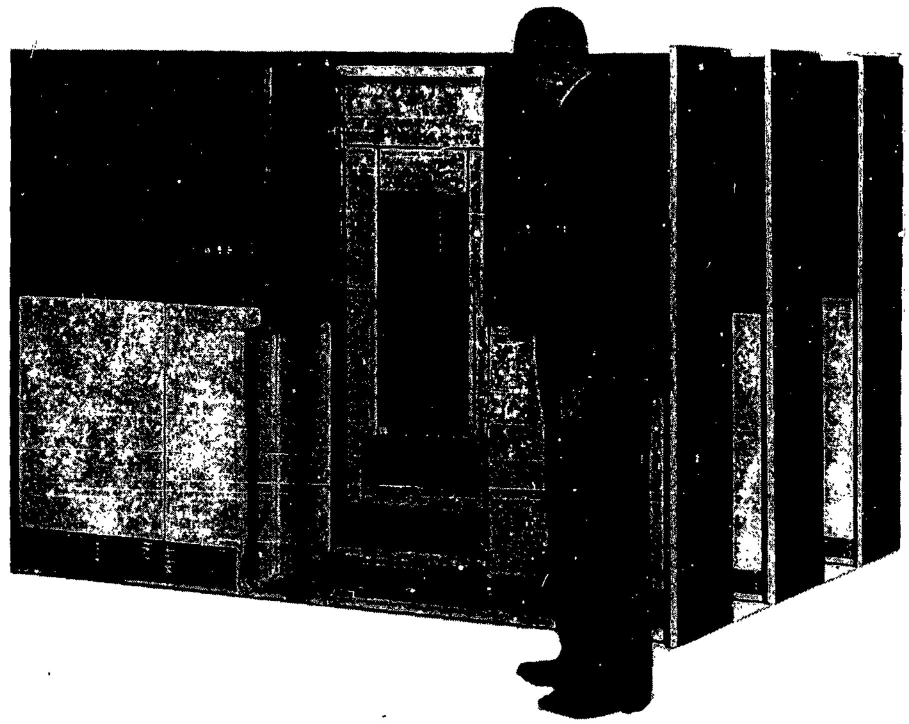
Paper Tape 1,000 char/sec
7 level code variable word length
Magnetic Tape 33,333 char/sec
3/4" Mylar 7 level code w/parity parallel dual recording.

RCA Service Company - E D P Sales Dept.

Magnetic Tape
7 channel Paper Tape
EAM Cards (80 Col.)

EDPD - New York Electronics System Center

Paper Tape	1,000 char/sec
Magnetic Tape	33 KC

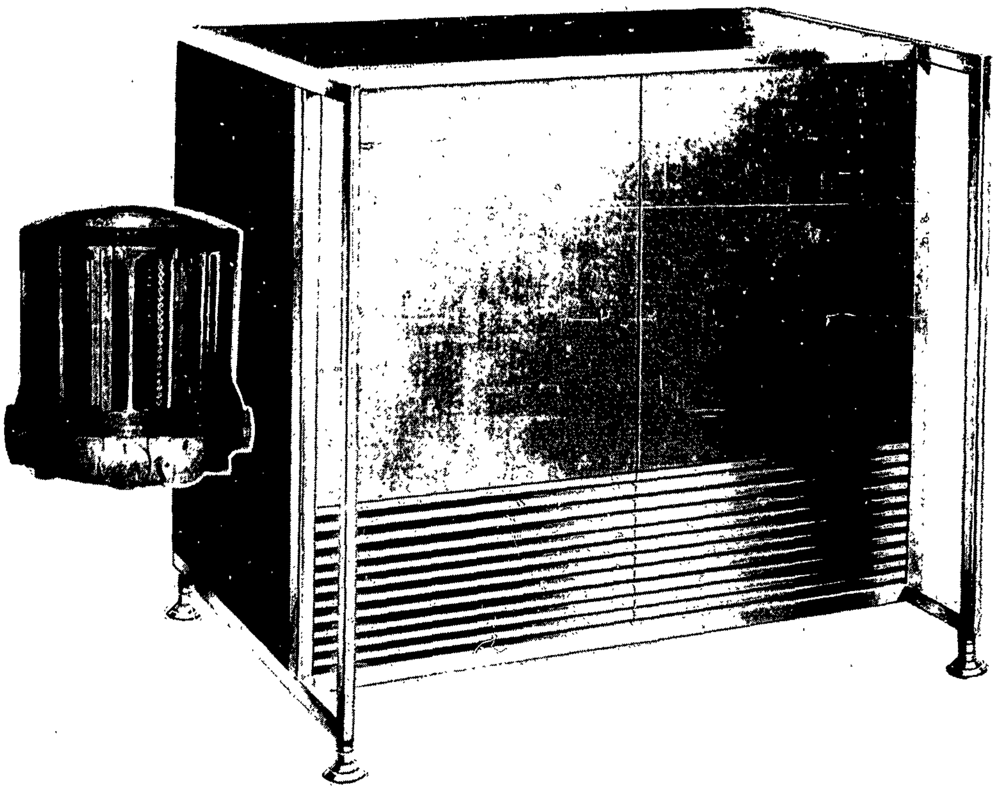


High Speed Magnetic Core Storage Photo by Air Reserve Records Center

RCA Astro Electronics Division
Media Speed
Cards
Paper Tape
Magnetic Tape
RCA Service Company, EDP Administration
Magnetic Tape
7 channel Paper Tape
EAM Cards (80 Col.)
Ordnance Weapons Command
Magnetic Tape 33,333 char/sec
Completed variable item of record length
Paper Tape 1,000 char/sec
On-line
Punch Cards 400 cards/min
Off-line
Magnetic tape speed - 100 inches/sec, packing at 333 1/3 chars/inch. Dual recording. Approximately 2400 ft per reel. Read reverse.
Atlantic City Electric Company
Punched Paper Tape 1,000 char/sec
Magnetic Tape 33,000 char/sec
7 level code (even parity) on 1 inch paper tape
Ordnance Ammunition Command
Paper Tape 1,000 char/sec
Magnetic Tape 33,000 char/sec
Raytheon Company - Missile Systems Division
Magnetic Tape 33,000 char/sec
3.5 mil sec start - stop time
Paper Tape Reader 1,000 char/sec
On-line
Card Reader 400 cards/min
Off-line

OUTPUT

Manufacturer
Media Speed
Magnetic Tape Approx 16,667 22,222 33,333 66,666 char/sec
File Control Unit Approx 18,700 char/sec
On-line Printing Up to 900 lines/min (120 chars)
Monitor Printing Up to 10 char/sec
On-line Card Buffer Up to 33,333 char/sec
Paper Tape (Punch) Up to 100 char/sec
U.S. Naval Propellant Plant
Paper Tape 10 char/sec
Monitor Printer 10 char/sec
Magnetic Tape 33,000 char/sec
Scott Air Force Base
High Speed Printer 600 lines/min
Magnetic Tape 33,000 char/sec
Card Punch 150 cards/min
Mitchel Air Force Base
High Speed Printer 600 lines/min
Off-line equipment. 120 characters per line.
Computer Monitor Printer 10 char/sec
On-line electric typewriter
Magnetic Tape 33,000 char/sec
Used with EMP off line or subsequent operation
Punched paper tape can be produced with simultaneous operation of Monitor Printer.



Random Access Drum Storage

Photo by Air Reserve Records Center

Fidelity-Philadelphia Trust Company

Media	Speed
High Speed Printer	600 lines/min

Down time has been negligible

General Tire and Rubber Company

High Speed Printer On-line	600 lines/min
Magnetic Tape	33.3 KC
Monitor Printer	10 char/sec

State Farm Life Insurance Company

Magnetic Tape (8)	33,333 char/sec
On Line Printer	600 lines/min 120 char/line
Monitor Typewriter	10 char/sec
Paper Tape	10 char/sec

Electronic Data Processing Division, RCA

Card	150 cards/min
Magnetic Tape	33 KC
Monitor Printer (Flexowriter)	600 char/min

RCA Electronic Systems Center

Magnetic Tape
Electro-Mechanical Printer
Monitor Printer

RCA Service Company - EDP Sales Dept.

Magnetic Tape
Paper Tape - (7) channel
EAM Cards
Monitor Printer
High Speed Printer

EDPD - New York Electronics System Center

Media	Speed
Magnetic Tape	33 KC
Electro Mechanical Printer - On Line	600 lines/min
Electro Mechanical Printer - Off Line	600-900 lines/min

RCA Astro Electronics Division

Card
Magnetic Tape
On Line Printer

RCA Service Company, EDP Administration

Magnetic Tape
Paper Tape (7) Channel
EAM Cards
Monitor Printer (Flexowriter)
High Speed Printer

Ordnance Weapons Command

Magnetic Tape	33,333 char/sec
Punch Cards Off-Line	150 cards/min
Hard Copy Off-Line	600 lines/min 120 char/line

Tape speed is 16,667 char/sec if destined for the Transcribing Card Punch.

Atlantic City Electric Company

Magnetic Tape	30 microsec/char
Printer (off line)	600 lines/min-Alpha Numeric 900 lines/min-Numeric only
Punched Paper Tape	100 char/sec

Magnetic Tape Storage

Photo by Air Reserve Records Center

Ordnance Ammunition Command

Media	Speed
Monitor Printer	10 char/sec
On-Line Printer	600 lines/min
Magnetic Tape	33,000 char/sec

A printer line consists of 120 characters.

Raytheon Company - Missile Systems Division

On-line Printer	600 lines/min
Card Punch (Off-line)	150 cards/min
Magnetic Tape	33,000 char/sec
Monitor Printer (Part of Console)	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type
Transistors
2N583
2N269
2N585
2N270
2N579
2N301
2N586
2N581
2N247
2N301
2N277
2N469
Diodes
1N97
1N270
1N91

Quantity depends on System.

CHECKING FEATURES

Accuracy Control is assured in the RCA 501 System by the following methods:

Computer - Model No. 503

Program Control

The following Program Control conditions cause the Computer to stop:

Incorrect parity in memory address register (3 characters)

Incorrect parity in memory register (4 characters)

Arithmetic unit malfunction

Incorrect parity in output of bus adder

Incorrect parity in normal operation register

Incorrect transfer of operation from normal to simultaneous mode

Time pulse generator malfunction

Malfunction of previous result indication

Illegal operand in decimal operation

Automatic Rerun

When selected, incorrect parity detected on reading from magnetic tape will automatically cause entrance to a routine which will back up the tape and re-read it. The computer will stop if incorrect parity is detected on re-reading.

Input-Output

The following input-output conditions cause the computer to stop:

Tape station reading extra bits in the gap

Missing timing bit when reading a character from the tape station

Tape station does not obey control signals

Odd number of characters from paper tape block read

Incorrect parity from tape read (see automatic re-run)

Incorrectly selected tape

Incorrect start message - end message sequence

Incorrect parity at the output of computer write buffer or absence of Write-Verify signal from tape station

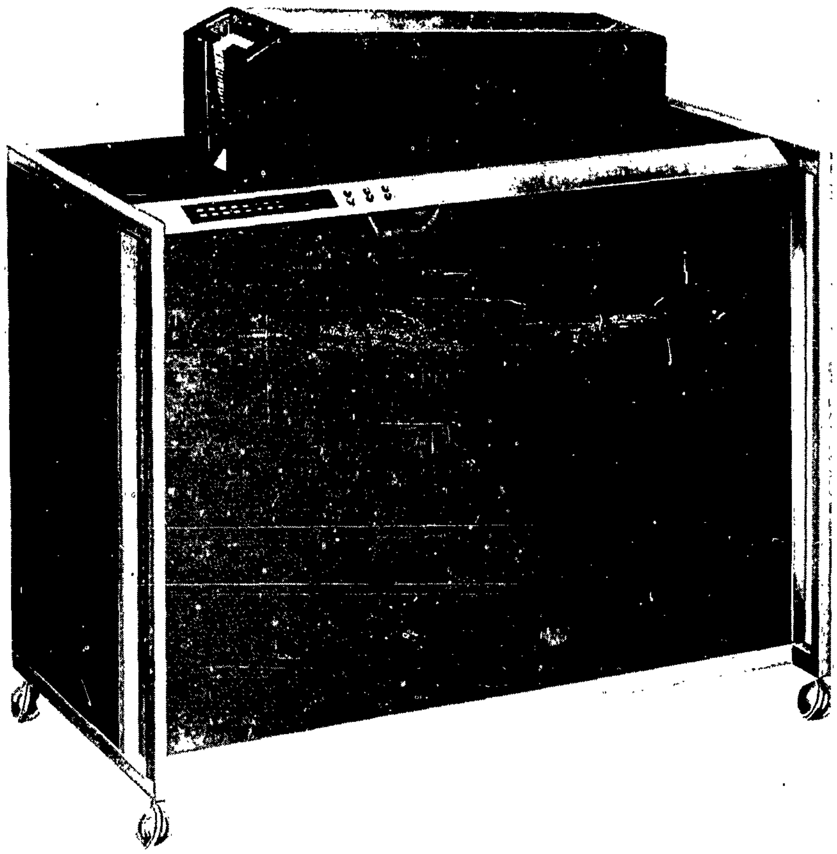
Incorrect paper tape parity

On-line printer not operable

On-line Printer paper supply low

Tape Station - Model No. 581

Remote lockout
Local lockout
Inoperable indication
Automatic stopping of tape at end of reel
Write lockout
Write verify
Write-to-read switching time
Dual Recording



Punched Card Input

Photo by Air Reserve Records Center

On-Line Printer - Model No. 533

The printer operation stops automatically under the following conditions, and signals are sent to the computer in order that corrective measures may be taken:

Low paper supply

Printer Unit inoperative (Motor switch is off or ribbon is inoperative)

A visual indication is given of the number of lines printed

Off-Line Printer - Model No. 535

Provisions are made for corrective measures to be taken when the following conditions occur:

Failure to print in a selected column or printing in an un-selected column (Print Error)

Low paper supply

Line overflow

Incorrect parity

Tape station inoperative

Printer unit inoperative

A visible indication is given of the number of lines printed or the number of messages printed depending on the plugboard connections.

Card Transcriber - Model No. 527

The following conditions initiate stopping of the equipment:

Incorrect parity at the input or output of the Card Editor or at the output of the Card Reader

Incorrect SM, EM sequence

Tape station inoperable

Failure of write verify check

Failure of comparison check

Failure of multi-punch check

Input hopper empty or output hopper full

E T W (End Tape Warning)

Card Reader - Model No. 528

The following conditions initiate stopping of the equipment:

Incorrect parity at the output of the Card Reader

Tape station inoperable

Failure of "Write Verify" check

Failure of comparison check

Input hopper empty or output hopper full

E T W (End Tape Warning)

Transcribing Card Punch - Model No. 537

The following conditions cause stopping of the equipment:

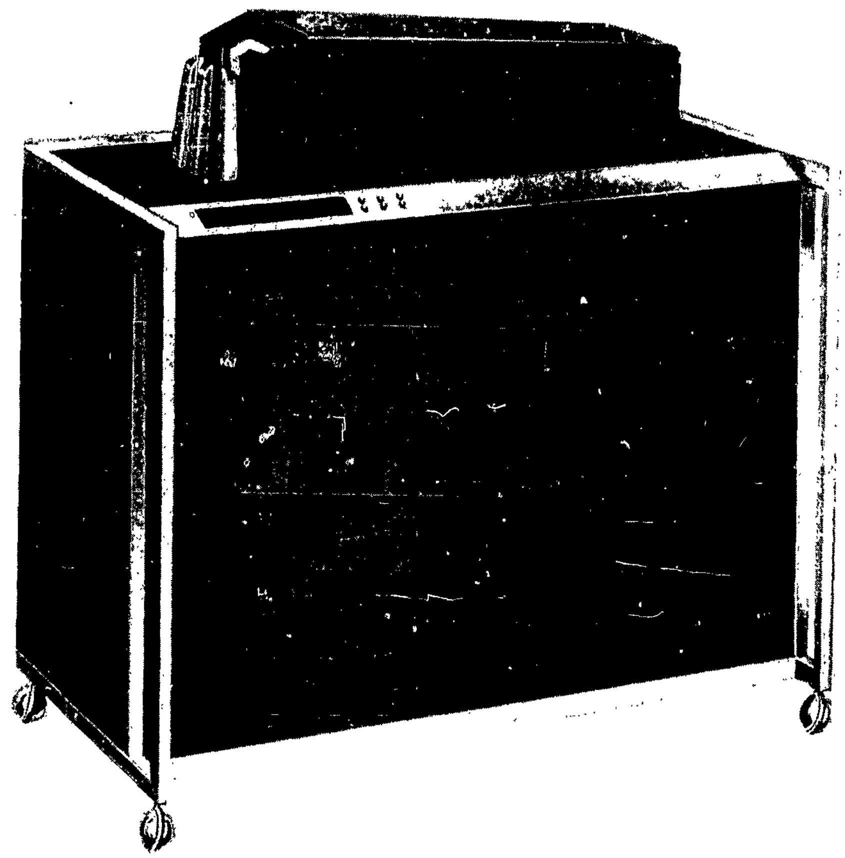
Incorrect parity at the input or output of the Electronic Unit Storage

Incorrect SM - EM sequence

Incorrect punching check

Input hopper empty or output hopper full

Tape station inoperable



Punched Card Output

Photo by Air Reserve Records Center

Card Punch - Model No. 538

The following conditions cause the machine to stop:

Incorrect punching
End file
End data
Feed failure
Output hopper full
Tape station inoperable

Tapewriter - Model No. 523

A parity check is included, which assures correct parity of all characters punched into the paper tape.

Detection of incorrect parity by the parity check mechanism will lock the keyboard and the Check Indicator will be illuminated until the Code Delete Key is depressed.

Simultaneous depression of two keys will neither print nor punch either character.

Tapewriter-Verifier - Model No. 525

Same as above.

Computer Punch - Model No. 512-5 and No. 512-7
Computer Punch - Model No. 513-5 and No. 513-7

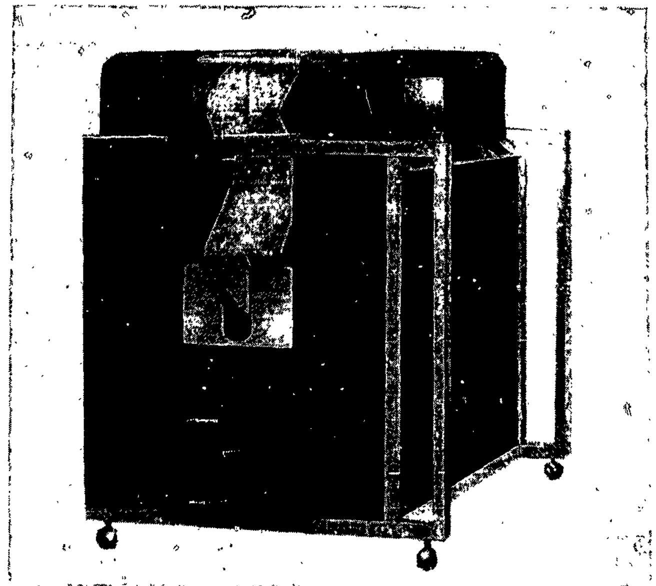
Information and control signals required to control the computer punch are derived from the computer. The required electrical returns from the computer punch to the computer are produced by the computer punch. Parity is checked at the computer punch; if incorrect parity is detected, the computer will stop and an indicator lamp on the computer console will light.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

	Manufacturer			
Power, system	5.6 Kw	230v	8.0 KVA	24,200 Btu/hr
Power, computer (excl high speed stor)	1.5 Kw	115-120v	2.1 KVA	
Volume occupied	300 cu ft			
Area occupied	64 sq ft			
Room size	375 sq ft			
Floor loading	13 lbs/sq ft, distributed			
	78 lbs/sq ft, concentrated			
Weight, computer	5,000 lbs, total			

Site preparation

The layout and installation criteria are flexible for the RCA 501 EDP System. Site preparation is a customer responsibility normally accomplished by electrical, mechanical and structural contractors employed by the customer in arrangements that are not part of the EDP equipment purchase lease or service. State and local laws and regulations require that a professional engineer or architect take responsibility for preparation of the site and procurement of necessary permits. RCA engineers are avail-



On-line Printer   Photo by Air Reserve Records Center

able to assist the customer in the installation planning.

U.S. Naval Propellant Plant

Power, computer 13.6 Kw 15.6 KVA, including tape stations and other peripheral equipment
Power, air conditioner 22 Kw 27.5 KVA
Volume, computer system 770 cu ft
Volume, air conditioner 1,000 cu ft
Area, computer system 98 sq ft
Area, air conditioner 100 sq ft
Room size, computer 27 ft x 27 ft
Room size, maintenance 17 ft x 13 ft
Room size, air conditioner 13 ft x 8 ft
Capacity, air conditioner 20 Tons
Air conditioner includes ADA system
Weight, system 10,000 lbs
Weight, air conditioner 2,000 lbs
Raised floor for cable runs, false ceilings, air conditioning through ducts in ceiling; existing building is earth-covered reinforced concrete; modifications required removing existing partitions, some electrical and other utility services but essentially no external modifications; power distribution new: 37.5 KVA single phase 2400/4160, 120/240v transformer.

Scott Air Force Base

Power, entire system 32.5 Kw 42.5 KVA
Volume, computer 11,664 cu ft
Volume, air conditioner 6,048 cu ft
Area, computer 1,296 sq ft
Area, air conditioner 504 sq ft
Room size, computer 36 ft x 36 ft x 9 ft
Room size, air conditioner 28 ft x 18 ft x 12 ft
Capacity, air conditioner 40 Tons; 10 Tons required for computer system
Weight, computer 13,300 lbs, total computer and components
Installed false ceiling, raised floor, and power requirements used existing room.

Mitchel Air Force Base

Model No.	Description	Equipment Area Sq Ft	Recommended Facility Area Sq Ft	Weight Lbs.	Concentrated Loading Lbs/Sq Ft	Distributed Loading Lbs/Sq Ft	Operational Kw	Max KVA	Prop KVA 208/120	BTU/Hr
503	Computer	64.0	375	5,000	78	13	7.1	10.1	8.0/2.1	24,200
523	Tapewriter & Table	22.0	50	185	8.4	3.7	0.2	0.25		685
581	Tape Station	6.2	25	900	145	36	1.1	1.3		3,750
561-2	High Speed Storage	23.6	110	1,500	127	27	3.0	4.3	2.9/1.4	10,240
	(The above items are located in the computer area)									
535	Electro-Mechanical Printer	20.4	125	1,500	73	12	4.9	6.1	5.6/.5	16,750
527	Card Transcriber	21.6	140	1,500	70	11	5.6	7.1	6.3/.8	19,800

(The printer and card equipment are located in 800 sq ft area adjacent to computer)

Assembly of Miniature Components Photo by Air Reserve Records Center

The building type is brick construction, cement floors with asphalt tile. The ceiling is acoustical panel suspended from wooden roof trusses. The basic modifications made for the computer included a raised all metal floor with 1/8" vinyl covering (Modular 4' x 2' floor panels), an inclosure of the entire computer area with movable steel partitions (Type "CC-Accoustiwall" by E. F. Hauserman Company), and an addition of a separate air conditioner for the computer area (27 linear diffusers each 48" x 12" - 195 cfm with 4" throw.) (Unit is Carrier type 39U11. Electro static air cleaner is Minneapolis Honeywell Model F22, No. 208 (Type C washing). Two condensing units, each with 325,000 BTU/hr at 105°F capacity (Carrier type 5H40 compressors.).

Installation of electrical circuits of data processing equipment included a new main power distribution panel-board with main feeders No. 4 350 MCM type RH and No. 1 1/0 ground wire, 3 1/2" conduit to trans. vault. Additional wiring circuits for air conditioning equipment and office lighting were also installed.

The original ceilings in the computer area were removed and installation of AMC metal pan (perforated) acoustic ceiling with metal attenuation pan was made. The suspension system was "Kemp" and the material was glass fiber sound insulating pads with minimum NRC of 0.85. The ceiling in the input-output area has the plenum above the whole area. The entire ceiling acts as a diffuser. This ceiling has no insulation and no attenuation pan. The raised floor serves as air return to air conditioner. The air conditioning equipment was placed on raised concrete floor (5000 No., 2 1/2" min over ribbed steel deck.)

Fidelity-Philadelphia Trust Company

Power, computer	26.6 Kw	34.3 KVA	0.77 pf
Power, air conditioner	42.53 Kw	49.48 KVA	0.862 pf
Volume, computer	13,016 cu ft		
Volume, air conditioner	4,933 cu ft		
Area, computer	1,627 sq ft		
Area, air conditioner	592 sq ft		
Floor loading	200 lbs/sq ft		
	1,000 concen max		
Capacity, air conditioner	30 Tons		
Weight, computer	2,000 lbs		
Weight, air conditioner	11,600 lbs		
Weight, total	15,200 lbs		

Plenum chambers, perforated metal ceiling, Belair flooring, storm windows, stainless steel framed viewing window, special power lines.

General Tire and Rubber Company

Volume, computing system	12,800 cu ft
Area, computing system	1,600 sq ft
Capacity, air conditioner	20 Tons

False ceiling, raised floor, wall insulation, wiring installation of two 10-Ton air conditioning units, partitioning, painting, etc.

Modular Assembly of Miniature Components

Photo by Air Reserve Records Center

State Farm Life Insurance Company

Power, computer	28.5 Kw	33.5 KVA
Area, computer	1,496 sq ft	
Room size	Irregular	
Weight, air conditioner	16,200 lbs	
Capacity, air conditioner	Two 5 Ton units	
	One 10 Ton unit	

Conventional wall to "room off" area. 20 Tons of supplementary air conditioning. Cables run between floor and dropped ceiling (already there) of rooms below. Necessary ducting was added for air conditioning.

Electronic Data Processing Division, RCA

Power, computer only	7.1 Kw	10.1 KVA, max
Area, computer	220 sq ft	
Room size required	2,000 sq ft	
Weight, computer and all peripheral		20,110 lbs
Capacity, air conditioner	30 Tons	

Air conditioning is chilled water system. False flooring is used.

RCA Electronic Systems Center

Power, computer	7.1 Kw	10.1 KVA	0.7 pf
Power, air conditioner	100 Kw	50 KVA	
Area, computer		64 sq ft	
Area, air conditioner		360 sq ft	
Room size, computer		375 sq ft	
Room size, air conditioner		400 sq ft	
Floor loading		13 lbs/sq ft	
		78 lbs concen max	
Capacity, air conditioner		70 Tons	
Weight, computer		5,000 lbs	
Weight, air conditioner		90 lbs/sq ft	

Site preparation requirements include false floor raceways for cable, carpeting, building brick - fireproof, and false ceiling plenum chamber for forced air system.

RCA Service Company - E D P Sales Dept.

Power, computer	65 Kw	85 KVA	0.77 pf

Set up for 2 system - only one now in use

Power, air conditioner	60 Kw	78 KVA	0.77 pf

Set up for 2 system - only one now in use

Volume, computer	2,430 cu ft
Volume, air conditioner	13,500 cu ft
Area, computer	441 sq ft
Area, air conditioner	1,350 sq ft
Room size, computer	38 ft x 100 ft
Room size, air conditioner	20 ft x 75 ft
Floor loading	13 lbs/sq ft
	900 lbs concen max
	145 lbs/sq ft max
Capacity, air conditioner	60 Tons + 30 Tons standby
Weight, computer	43,500 lbs
Weight, air conditioner	13,620 lbs

Site preparation requirements include seven (7) inch raised floor for cable distribution, acoustical tile false ceiling and complete automatic CO_2 fire extinguishing system with central control panel indication.

RCA Astro Electronics Division

Power, air conditioner	20 HP
Volume, computer	15,000 cu ft
Volume, air conditioner (with plenum)	1,350 cu ft
Area, computer	90 sq ft
Area, air conditioner	90 sq ft
Room size	1,000 sq ft
Capacity, air conditioner	20 Tons
Weight	20 Ton Worthington Unit

RCA Service Company, EDP Administration

Power, computer	7.1 Kw	10.1 KVA
Area, computer	64 sq ft	
Room size	375 sq ft	
Floor loading	13 lbs/sq ft	

Automatically Printed Wiring   Photo by Air Reserve Records Center

Floor loading 78 lbs concen max
Weight, computer 5,000 lbs

Site preparation requirements include raised floor, increased air conditioning, ceiling to floor partitioning for classrooms, and acoustical tile false ceiling. Air conditioning is an extension of the building air conditioner.

Ordnance Weapons Command

Power, computer	31.9 Kw	40.25 KVA
230V ± 10%, 60 cycle		
Power, air conditioner	60.5 Kw	
Volume, computer	1,082 cu ft	
Volume, air conditioner	5,600 cu ft	
Area, computer	209 sq ft	
Area, air conditioner	800 sq ft	
Room size, computer	3,652 sq ft	
Room size, air conditioner	1,600 sq ft	
	80 x 20 x 10 ft	
Floor loading	113 lbs/sq ft	
	200 lbs concen max	
Capacity, air conditioner	84 Tons	
Weight, computer	23,500 lbs	
Weight, air conditioner	12,000 lbs	

Space can accommodate twice the complement now installed. Figures are for full complement, including off line equipment.

Converted loft type warehouse, reinforced concrete construction. False floor installed to permit all cabling under the floor. Concrete block interior walls except Tape Library which has semi-permanent steel walls. False ceiling, metal, sound absorbing, under concrete ceiling. Extension of bus ducts from 4th floor to 1st floor (± 65 ft). Equipment itself requires 24 tons of air-conditioning. Balance is for latent and ambient heat for a total of 24,000 sq ft area.

Atlantic City Electric Company

Power, computer	7.1 Kw	10.1 KVA
Volume, computer		320 cu ft
Area, computer		64 sq ft
Room size, computer		375 sq ft
Floor loading		13 lbs/sq ft
		78 lbs concen max
Weight, computer		5,000 lbs

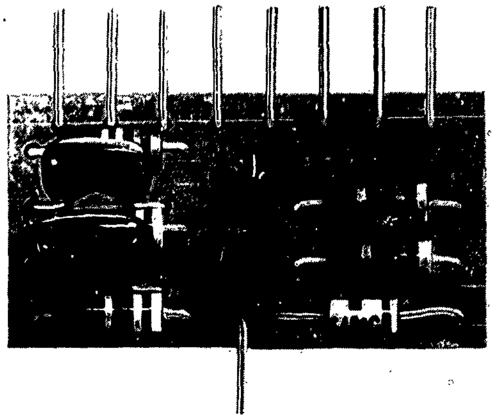
Air conditioner is part of general conditioning system for entire building.

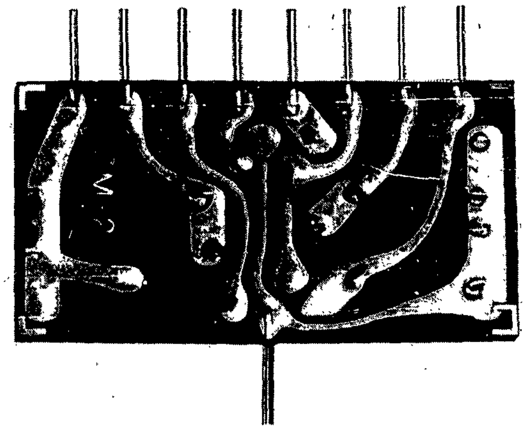
Computer installed in new buildings whose design included necessary structural considerations.

Ordnance Ammunition Command

Power, computer	74.1 Kw	90.5 KVA
Power, air conditioner	71.9 Kw	
Volume, computer	8,160 cu ft	
Volume, air conditioner	907 cu ft	
(includ condensers, cooling tower & air filter)		
Area, computer	280.20 sq ft	
Area, air conditioner	120 sq ft	
Room size, computer	1,600 sq ft	
Room size, air conditioner	343 sq ft	
Floor loading	513.60 lbs/sq ft	
	3,112.20 lbs concen max	
Capacity, air conditioner	50 Tons	
Weight, computer	17,600 lbs	
Weight, air conditioner	12,162 lbs	

Required installation of pedestal type floor - painted combustible walls with fire retardant paint- modified air conditioner ducts to channel return air thru electro dust filter.





Standardized Modules

Photo by Air Reserve Records Center

Raytheon Company - Missile Systems Division

Power, computer	30.25 Kw 38.9 KVA (Complete System)
Power, air conditioner	23 Kw
Volume, computer	21,600 cu ft
Volume, air conditioner	12,480 cu ft
Area, computer	2,160 sq ft
Area, air conditioner	1,060 sq ft
Room size, computer	40 ft x 54 ft
Room size, air conditioner	(47 ft 4 in) x (22 ft 4 in)
Floor loading	100 lbs/sq ft
	100,000 lbs concen max
Capacity, air conditioner	20 Tons
	450 cfm per ton
Weight, computer	16,200 lbs
Weight, air conditioner	5,000 lbs

Exterior walls are filled concrete blocks, plastered and covered with "Kalistron".

Interior partition is floor to ceiling metal and glass partitions.

Windows are existing metal frame windows removed and space filled with glass blocks.

Ceilings are hung metal pan type with glass wool insulation. Also included flush type fluorescent lighting, supply and return air diffusers.

Floors are aluminum and tile raised floor as manufactured by "Lisky".

Protection of tape library is accomplished by an automatic CO_2 flooding system. Remainder of area is protected by a combustion sensitive "pyralarm" which opens power circuit to computer equipment and air conditioning system and signals alarm adjacent to the room and in Main Guard House.

Power distribution is by main feed panel in computer room through cables under raised floor to each piece of equipment.

The air conditioning equipment is housed in a room built into a monitor centered over the main floor, outside and to the north of the computer area. Exterior walls and flooring are made up of metal partitions as manufactured by "Mahon". Interior flooring is made up of 2" x 6" matched boards. All construction is for a four hour fire protection as requested by F. I. A.

PRODUCTION RECORD

Number produced to date	24
Number in current operation	16
Time required for delivery	12 months

COST, PRICE AND RENTAL RATES

		Basic System	Sales Price
1	503	Computer	$ 257,000
1	561-1	Hi-Speed Storage (16,384 char)	120,000
6	581	Tape Stations (33,333 char/sec)	29,700 ea
1	523	Tapewriter	3,300 ea
1	525	Tapewriter-Verifier	4,500 ea
1	533	On-Line Printer	60,000 ea
1	580	Tape Station (22,222 char/sec)	$ 25,190
1	582	Tape Station (66,666 char/sec)	
1	535	Off-Line Printer (600 lines/sec)	
1	561-2	High-Speed Storage (32,768 char)	
1	561-3	High-Speed Storage (49,152 char)	
1	561-4	High-Speed Storage (65,536 char)	
1	543	Tape Selecting Unit (additional 8 sta)	
1	595	Tape Selecting Unit (additional 16 sta)	
1	527	Card Transcriber (400 cards/min)	
1	528	Card Reader (400 cards/min)	
1	537	Transcribing Card Punch (150 cards/min)	
1	538	Card Punch (150 cards/min)	
1	567	Random Access File (1,500,000 char)	
1	560/597	File Control & Power Units	$ 110,000
1	512-5/7	On-Line Paper Tape Punch (100 char/sec)	17,200
1	513-5/7	On-Line Paper Tape Punch (300 char/sec)	38,700
1	551	On-Line Card Buffer	
1	523	Tapewriter	
1	525	Tapewriter-Verifier	
	547-6	Tape Switching Unit	11,800

Quan	Model	Basic System	Monthly Rental
1	503	Computer	$ 5,400
1	561-1	Hi-Speed Storage (16,384 char)	2,400
6	581	Tape Stations (33,333 char/sec)	550 ea
1	523	Tapewriter	110 ea
1	525	Tapewriter-Verifier	150 ea
1	533	On-Line Printer	1,300 ea
1	580	Tape Station (22,222 char/sec)	$ 465
1	582	Tape Station (66,666 char/sec)	
1	535	Off-Line Printer (600 lines/min)	
1	561-2	High-Speed Storage (32,768 char)	
1	561-3	High-Speed Storage (49,152 char)	
1	561-4	High-Speed Storage (65,536 char)	
1	543	Tape Selecting Unit (additional 8 stations)	
1	545	Tape Selecting Unit (additional 16 stations)	
1	527	Card Transcriber (400 cards/min)	
1	528	Card Reader (400 cards/min)	
1	537	Transcribing Card Punch (150 cards/min)	
1	538	Card Punch (150 cards/min)	
1	567	Random Access File (1,500,000 char)	
1	560/597	File Control & Power Units	1,525
1	512-5/7	On-Line Paper Tape Punch (100 char/sec)	400
1	513-5/7	On-Line Paper Tape Punch (300 char/sec)	900
1	551	On-Line Card Buffer	
1	523	Tapewriter	
1	525	Tapewriter-Verifier	
1	547-6	Tape Switching Unit	300

Maintenance and service contracting benefits:
- Industrial Specialists
- Debugging Time Allowed
- Standard Programs
- General Backup
- Executive Orientation

U.S. Naval Propellant Plant

			Price	Monthly Rental
One	503	Computer	$257,000	$ 5,400
One	561-2	High Speed Storage	177,000	3,400
Five	581	Magnetic Tape Stations	148,500	2,750
One		Tapewriter Verifier	4,500	150
		Total	$587,000	$11,700

Scott Air Force Base

One 503 Computer, one 561-1 High speed storage, five 581 Tape stations, one 533 On-line printer, and one 538 Card punch rents for a total of $13,850 per month. A 5 to 7 channel tape to tape converter and a PCAM card to 7 channel tape converter caused a one-time cost of $6,790. Maintenance and service is included in rental.

Mitchel Air Force Base

The Air Reserve Records Center system consists of

	Model	Description
1	503	Computer, less High Speed Storage Unit (Includes Program Control, Console, Paper Tape Reader, Monitor Printer, Tape Selecting and Buffer Unit - A (eight trunks and Power Supply).
1	561-2	High Speed Storage (32,768 characters)
10	581	Tape Station, 33,333 char/sec
1	535	Electro-Mechanical Printer (Off line 600 lines/min)
1	527	Card Transcriber

For sales and rental prices, see page 16 of GSA Contract No. GS-00S-23296.

Fidelity-Philadelphia Trust Company

System rents at $16,150 per month, including maintenance.

General Tire and Rubber Company

Computer, console, 8 tape stations, paper tape reader, on-line printer and 2 tapewriters rent at approx $16,000.

State Farm Life Insurance Company

503 Computer, 561-3 High Speed Storage, eight 581 tape stations, 533 High speed printer, six 523 Tapewriters, twenty-four 525 Tapewriter-Verifier, rents at $19,760 per month. Two 527 Card Transcribers and a 5971 Tapewriter Reader, temporary for conversion period, rent at $4,550 and $160 per month. Rental includes maintenance.

Electronic Data Processing Division, RCA

System configuration is as follows:

503	Computer
561-4	High Speed Memory
	Paper Tape Reader
	Monitor Printer
581 (8)	Tape Stations
547-6 (6)	Tape Switching Unit
537	Transcribing Card Punch
527	Card Transcriber

RCA Electronic Systems Center

Cost of basic system	$586,000
Cost of additional equipment	$1,359,800
Rental rate for basic system	$11,850 per month
Rental rate for additional equipment	$26,570 per month

Maintenance and service contracting is included in rental.

RCA Service Company - E D P Sales Dept.

System includes one 503 Computer, one 543 Tape Selector, one 561-4 High Speed Storage, twelve 581 Tape Stations, one 533 E. M. Printer, one 547-6 Tape Switching Panel, one 513-7 Hi Speed Paper Tape Punch and at a total rental of $21,100 per month.

System includes three 581 Tape Stations, one 535 EM Printer, one 527 Card Transcriber, one 537 Transcribing Card Punch, two 523 Tape Writers, and two 525 Tape Writer-Verifiers at a total rental of $10,700 per month.

Maintenance is performed by our technicians, who are a combination of operators and maintenance technicians.

EDPD - New York Electronics System Center - System Configuration

Model No.	Quantity	Description	Sales Price	Monthly Rental
503	2	Computer	$ 257,000	$ 5,400
561-4	2	High Speed Storage	291,000	5,400
543	2	Tape Sel. B-1	56,700	1,200
581	27	Tape Stations	29,700	550
533	2	Electro Mechanical Printer (On Line)	60,500	1,300
535	2	Electro Mechanical Printer (Off Line)	170,000	3,400
527	2	Card Transcriber	103,000	2,275
537	2	Transcriber Card Punch	148,300	2,965
523	2	Tape Writer	3,300	110
525	2	Tape Writer Verifier	4,500	150
547-6	2	Tape Switching Unit	11,800	300
513-5	2	Paper Tape Punch	38,700	900
513-7	2	Paper Tape Punch	38,700	900

All sales and monthly rentals are for a quantity of one.

RCA Astro Electronics Division

Rental contracting and rates for system

Model	Description	Monthly Rental
503	Computer, less High Speed Storage Unit	$5,400
561-1	High Speed Storage (16,384 char)	2,400
581	Tape Stations, 33 KC (4)	2,200
533	On Line Printer (600 lines/min)	1,300
567	Random Access File	500
568	File Control Unit	1,375
597	Power Supply	150
538	Card Punch	1,700
591	Card Reader Punch	1,500
525	Tapewriter Verifier	150

RCA Service Company, EDP Administration

System, composed of Tape Stations (12), Computer, High Speed Storage, Tape Selector B-1, Card Transcriber, Transcribing Card Punch, Printer Off-line, and Tapewriter-Verifier, sells at a total sales price of $1,215,900.

Rental for above equipment on an 8 hour shift, 5 days per week for 1 month is $24,390.

Ordnance Weapons Command

5 Tape Stations, On-Line Printer, Computer, Paper Tape Reader, Monitor Printer, and one Module Memory, rents at $11,800 per month.

5 Tape Stations, 3 Modules Memory, Off-Line Card Transcriber, Transcribing Card Punch & Electro- Mechanical Printer rents at $16,510.

Maintenance is included in basic rental.

Atlantic City Electric Company

Main frame rents at $7,800 per month.

7 Tape Stations, Off-line Printer, computer punch, 4 tapewriters, 4 tapewriter-verifiers, and 4 add-punches rents at $9,285 per month.

Ordnance Ammunition Command

Total rental is $17,585 per month.

Raytheon Company - Missile Systems Division

8 tape stations, 1 503 computer, 2 Modules (Hi-speed memory), 1 On-line Hi-speed printer, and rents at $14,500 per month.

7 tapewriters, 6 tapewriter verifiers, 1 card transcriber, 1 card punch, and 1 tape switching unit rents at $5,945 per month.

PERSONNEL REQUIREMENTS

Manufacturer's recommendation for a "typical" system

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	2	3
Analysts	*	*	*
Programmers	*	*	*
Coders	*	*	*
Clerks	*	*	*
Librarians	1	2	3
Operators	3	5	7
Technicians	2	4	5
In-Output Oper	1	2	3
Tape Handlers	1	2	3

*Variable depending on problem.

Training made available by Manufacturer to Users as required. Analyst Training, Technical Training, Automatic Programming Training, Pre-Installation Training of Operators, Coders, clerks, etc, and Operator Training are made available. The figures on personnel requirements are approximate and depend on the size of the system.

U.S. Naval Propellant Plant

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts	2*	2
Programmers	1	4
Coders	0	1
Clerks	1	1
Librarians	1	1
Operators	2	2
Engineers	**	**
Technicians	**	**

Operation tends toward closed shop.

RCA-supplied training course. Accelerated course given mathematicians at NPP.

*Analysts do programming and coding because of present personnel shortage. Because of a lack of operators for the machine being utilized, they also have acquired the ability to operate the machine.

** Engineers and Technicians are RCA personnel.

Scott Air Force Base

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts
	Used	Recom	Used	Recom	Recommended
Supervisors	2	2	2	2	2
Analysts	4	4	4	4	4
Programmers	10	10	10	10	10
Clerks	1	1	1	1	1
Operators	1	1	3	3	8
Tape Handlers	1	1	3	3	8

Operation tends toward open shop (USAF).

Personnel were selected within this command for computer training on the basis of computer aptitude and speciality background. We attempted to select personnel with background training in each of the applications scheduled for the computer, e.g., based upon our expected requirement for analysts and programmers for the personnel application, we selected personnel with high computer aptitude and previous personnel experience.

Mitchel Air Force Base

	One 8-Hour Shift		Two 8-Hour Shifts	
	Used	Recommended	Used	Recommended
Supervisors	2	11	11	12
Analysts	4	6	-	-
Programmers		15	17	17
Coders		0	0	0
Clerks		3	3	4
Librarians		1	1	2
Operators		1	6	3
Engineers		3	10	10
Technicians		0	0	0
In-Output Oper		0	0	0
Tape Handlers		2	0	3

Methods of training used

Programmers - Five weeks formal classroom and on-the-job training - total 12 months

Operators - Two weeks classroom and 5 1/2 months on-the-job training - total 6 months

Organization consists of Data Development Division (Programming and Operations) and System Analysis Division. One position in System Analysis Division is concerned with ADP equipment and use in our system.

"Used" personnel are in Systems Analysis Division. "Recommended" is combination of both Divisions.

Programmers at this installation are analyst trained. Analysts in Systems Analysis Division are former programmers.

This installation operates 20 hours per day and 9 hours on Saturday. Overtime is not normally required in the operating area.

Engineers are furnished by the contractor.

Operators presently perform all operating functions, i.e., peripheral equipment operation, tape handling, and console operation.

Fidelity-Philadelphia Trust Company

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	2		
Programmers	6		
Librarians	1		
Operators	1		
Engineers	2	1	1
Technicians		2	2
In-Output Oper	1		
Tape Handlers	1		

Operation tends toward open shop.

Methods of training used include RCA Schools plus on-the-job training.

General Tire and Rubber Company

	One 8-Hour Shift
Supervisors	1
Programmers	1
Clerks	1/2
Librarians	1/2
Operators	2
Engineers	2
Technicians	1

Operation tends toward closed shop.

Methods of training used are RCA personnel-conducted courses.

State Farm Life Insurance Company

	One 8-Hour Shift
Supervisors	3
Analysts	3
Programmers	10
Clerks	6
Librarians	1
Operators	4
In-Output Oper	29

Not in production as yet. These are anticipated figures.

Operation tends toward open shop.

RCA for programmer and operator training.

Electronic Data Processing Division, RCA

Operation tends toward closed shop.

Methods of training used are RCA training schools, plus on-the-job training.

RCA Electronic Systems Center

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	Used	Recomm	Used	Recomm	Used	Recomm
Supervisors	1	1	2	2	3	3
Librarians	1	1	1	1	1	1
Operators	1	1	2	2	3	3
In-Output Oper	1	1	2	2	3	3
Tape Handlers	1	1	2	2	3	3

Operation tends toward open shop.

Methods of training used includes 5 weeks program training and on-the-job training in operations.

The shift supervisor, operator, and tape handler rotate between jobs - actually use three men per shift on all equipments. Programmers, analysts, etc. are not part of Operations group. Support in this area comes from another group.

RCA Service Company - E D P Sales Dept.

	One 8-Hour Shift
Supervisors	5
Analysts	5
Programmers & Coders	7
Clerks	10
Operators*	*8
Technicians*	
Tape Handlers*	
Salesman	

Personnel shown are [illegible] shift operation on one system with maintenance on a 24-hour 7-day basis. Approximately 12 additional operator technicians and programmers will be required upon installation of 2nd system. Operators, technicians and tape handlers also perform demand and preventive maintenance.

Supervisors consist of Center Manager, Sales Manager, Systems and Programming Manager, Operations Manager and Office Manager. Clerical personnel include Office Administrative, Sales and Accounting functions in addition to data preparation operations.

Operation tends toward closed shop.

Operator technicians trained for 6 months at school and thereafter on the job.

Experienced Systems Analysts and Programmers attend 4 week programming course and untrained employees receive an 8 week basic training course plus on-the-job training.

EDPD - New York Electronics System Center

Operation tends toward closed shop.

Programmers given formal school training and on-the-job training.

RCA Astro Electronics Division

	One 8-Hour Shift
Supervisors	1
Analysts	2
Operators	2

Operation tends toward open shop.

We use our own training program for computer center personnel and personnel who submit problems to the Computer Center.

A three tier approach is used for personnel requirements for the Computer Center.

1. Professional programmers are attached to the Computer Center. (2 + a supervisor)

2. Project programmers, who are considered professional programmers, are attached to the Engineering Sections that are developing projects. They work in concert with competent line engineers in developing programs.

3. Open Shop Engineer Personnel. These are engineers who are trained by us to develop and program the less complicated problems.

RCA Service Company, EDP Administration

This system is used for training of service personnel to support EDP Operations in the Field.

Ordnance Weapons Command

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	6	10
Analysts	21	21
Programmers	21	26
Clerks	6	7
Librarians	1	2
Operators	4	4
In-Output Oper	6	6

Personnel were selected from within the installation with emphasis on obtaining some from each of the application areas (subject matter specialists). Others had specific backgrounds desirable, i.e. Management Analysts, Accountants, Mathematicians/Statisticians and Tab Equipment Planners. There is no job as Coder, per se. When using object or machine coding, each programmer codes his own. On large program, he may have assistance. There are no tape handlers. Equipment operators perform the function when set-ups are required. Input-Output operators include 4 tapewriter and tapewriter verifier operators. Initially operation is on a closed shop basis, but as each application becomes operational, analysts are placed in "customer" organization.

United States Civil Service Commission training agreement calls for six month program; a 1 week orientation -classroom, 4 weeks programmer training by RCA - classroom, 4 weeks applied problems - half classroom, half on-the-job training, 1 week advanced analysis - classroom, and on-the-job training.

Atlantic City Electric Company

	One 8-Hour Shift Recommended
Supervisors	4
Analysts	1
Programmers	2
Clerks	3
Librarians	1
Operators	3
In-Output Oper	12

Operation tends toward open shop.

Training is performed on site and at manufacturer's schools.

Computer is in process of being shaken down during system testing and parallel production runs. Recommended organization shown above is the anticipated requirement. The manufacturer will have a maintenance staff of 8 employees on site.

Ordnance Ammunition Command

	One 8-Hour Shift
Supervisors	6
Analysts	7
Programmers	15
Clerks	2
Librarians	2
Operators	4
In-Output Oper	3
Tape Handlers	2

Operation tends toward open shop.

Methods of training used includes manufacturer's training courses, specialized OMETA courses, guided applications and on-the-job training.

Raytheon Company - Missile Systems Division

	One 8-Hour Shift	
	Used	Recommended
Supervisors	2	Depends on projects
Analysts	9	Depends on projects
Programmers	15	Depends on projects
Librarians	1	1
Operators	1	1
Engineers	2	3
Technicians	1	1
In-Output Oper	1	1
Tape Handlers	1	1

Operation tends toward closed shop.

Methods of training used include programming and technical training given on-site by RCA instructors. RCA maintains several full time on-site representatives for methods assistance. Classes, case problems and on-job training is also given.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Reliability is obtained by dual recording on tape, simultaneous operation, automatic accuracy checks, lockout features of the Input-Output equipment, and tape flow sensing.

U.S. Naval Propellant Plant

Installation date for NPP equipment was 1 June 1960. At present, Bureau of Weapons equipment is being utilized.

Scott Air Force Base

Good time 145 hrs 45 min Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 95%
Above figures based on period 1 Apr 60 to 30 Apr 60
Date system passed 9 Mar 60
Time is available for rent to outside organizations.

We are currently preparing programs for the support of Hqs Air Weather Service. We expect to utilize approximately 30 hours of computer time for these applications.

Mitchel Air Force Base

Good time 78 Hours/Week (Average)
Attempted to run time 98 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.795
Above figures based on period 1 Jan 60 to 1 May 60
Date this system passed 9 Nov 59
Time is not available for rent to outside organizations.

Fidelity-Philadelphia Trust Company

Good time 15 Hours/Week (Average)
Attempted to run time 15-16 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.984
Above figures based on period 2 Jun 60 to 18 Jun 60

Date this system passed 11 Jan 60
Time is available for rent to outside organizations.
Have had no down time 9 Jun 60 to 18 Jun 60, inclusive.
Rent 8 hours per day to R.C.A.

General Tire and Rubber Company

Good time 39 Hours/Week (Average)
Attempted to run time 35 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 11 Apr 60 to 6 May 60
Date this system passed 11 Apr 60
Time is available for rent to outside organizations.

State Farm Life Insurance Company

Date this system passed 1 Mar 60 to 28 Mar 60
Time is available for rent to qualified outside organizations.
Experience to date limited to system and program testing. Progress is satisfactory and improving.

Electronic Data Processing Division, RCA

Good time 110 Hours/Week (Average)
Attempted to run time 112 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period Jan 59 to 16 Jun 60
Time is not available for rent to outside organizations.

RCA Electronic Systems Center

Good time 118.3 Hours/Week (Average)
Attempted to run time 120 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.985
Above figures based on period Dec 59 to May 60
Date this system passed 15 May 59
Time is available for rent to outside organizations.

RCA Service Company- E D P Sales Dept.

Date this system passed 16 May 60
Time is available for rent to outside organizations.

RCA Astro Electronics Division

Operating ratio (Good/Attempted to run time) 100
Above figure based on period from 6 weeks to date
Date this system passed Initial system 1 Jan 60
Time is available for rent to outside qualified organizations.
Due to short length of time since installation we cannot make a definitive statement as to our running time. However our experience has been good. After acceptance test we started at 80% running time and have improved to 100% for the past six weeks.

RCA Service Company, EDP Administration

Time is not available for rent to outside organizations.

Ordnance Weapons Command

Average error-free running period 48 Hours
Good time 82.7 Hours/Week (Average)
Attempted to run time 83.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.99
Above figures based on period 1 Jul 60 to 30 Jul 60
Time is available for rent to outside organizations on a limited basis.
RCA Maintenance requires minimum of 90 minutes daily. Time is available from midnight until 0530. Computer good time is over 99% over a six month period. Down time accumulated is primarily due to tape station malfunction and secondarily due to the paper tape reader. (Electro-Mechanical devices).

Raytheon Company - Missile Systems Division

System passed Customer Acceptance Test 26 Jul 60

ADDITIONAL FEATURES AND REMARKS

Manufacturer

The RCA 501 System can be tailored to fit the needs of the user. It takes advantage of the latest programming techniques and can be expanded to suit future needs. The design concept, using completely transistorized circuit modules, saves power and space. Reliability and savings in maintenance costs have been realized by actual field operational data. Records (word) lengths are completely variable both on tape and in memory. Unique symbology on tape tells the computer where messages and items begin and end. Thus, artificial fixed word or fixed maximum word lengths do not have to be resorted to i.e., each item and message occupies on tape only the exact space that it requires. Blocks of several messages may also be variable in length. The system handles all of this automatically.

U.S. Naval Propellant Plant

Outstanding features: Completely variable recording of data; building block or modular expansion principle; transistorized; fast speed (microsecond access); simultaneous tape read-compute, write-compute, read-write operations.
Unique system advantages: Ability to perform real-time operations with modification; fast tape speeds; ability to perform binay operations through its special binary instruction codes.
The RCA 501 Computer System is the only one in its price class and currently available which satisfies the on-line, real-time requirements of the NPP workload. The tape speeds can accommodate 15,000 data points per second for NPP's real-time applications.

Scott Air Force Base

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage. All magnetic tapes are assigned an inventory number and are labeled with its content. A current inventory card is maintained reflecting current and previous content, reuseable date and labeling information. Each program is so designed to check the label of each tape used to insure that proper tapes are mounted for use. Tapes are stored in a separate room, under the same temperature and humidity controls as the computer.

Mitchel Air Force Base

Outstanding features include transistor design, plug-in assemblies, printed wiring, modularized components, building-block construction, simplified automatic control, complete variable data recording, and tape reading/writing is possible in both forward and reverse directions.
Unique system advantages include four-character parallel transfer, increased data transfer rates, and addressable registers. Built-in and programmed accuracy controls, checking correct transfer of data in peripheral devices, into and out of the computer, and within the computer proper; additional controls ascertain correct arithmetic operations. Time-shared electronics, permitting simultaneous operation of input-output devices with computer functions. Complete range of computer instructions; 47 basic, wired-in, two-address instructions for input-output (12) data - handling (13), arithmetic (11), and decision and control (11).

Magnetic tape labelling is done. Storage for magnetic tapes is provided in the computer room and each tape is in a dust proof clear plastic container. The containers are stored in metal cabinets. In addition, Master Personnel tapes (The 2 most recent "as of" dates) are maintained in a separate vault (approximately 300' and 2 firewalls away from computer, but in same building). Because of presence of operating personnel and technicians on 24 hours basis, no special warning devices or controls to indicate humidity, temperatures, electrical or other damage. We have not shipped magnetic tapes but are studying means of protection for use at later date when we will be shipping tapes to other installations.

Fidelity-Philadelphia Trust Company

Outstanding features include building block principle, transistorized, and low unit cost.

Unique system advantages include a completely variable word length.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include duplicate tapes stored in vaults, tapes labelled internally as well as externally, and a 40-Ton air conditioner serves as back up.

General Tire and Rubber Company

Outstanding features include variability of field size.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage, include normal computer room procedures and restrictions.

State Farm Life Insurance Company

Unique system advantages include daily cycle policy record updating.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage, all of these procedures considered as "normal" for e.d.p.

Electronic Data Processing Division, RCA

Outstanding features include reading magnetic tape in both directions, complete flexibility of the console, and easy matching color decor.

RCA Electronic Systems Center

Other outstanding features include complete transistorization throughout system. Expandability in core memory-tape stations and configuration of peripheral equipment.

Unique system advantages include complete service routine package-memory serial (re-programming not necessary with additional memory).

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include blank label for customer preference, metal cabinet in air conditioned room for storage, and no special fireproofing or protection.

RCA Service Company - E D P Sales Dept.

Outstanding features include completely transistorized; high processing speeds at low costs; operates with completely variable length data items; automatically controls up to 62 magnetic tape trunks; automatically controls random access drum storage (expansible in steps of 1 1/2 million characters); simultaneous on line print/read, write or compute; simultaneous magnetic tape read-compute, write-compute, read-write; reads magnetic tape in forward or backward motion; permits programming methods which can save 30% to 50% program storage space; and transfers 1 or 4 alpha-numeric characters in 15 microseconds.

The RCA 501 Electronic Data Processing System is a general-purpose system using transistor logic. The design employs the "building-block" principle which results in an expandable, highly flexible, integrated data processing system. Because of this "building-block" principle, the System can be tailored to present needs and can be expanded to meet future requirements.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage are separately zoned air conditioning for computer room with temperature of 72° - 80° with variance of only $\pm 2^\circ$ over 6 hour period. Humidity control maintained at 20% - 65% with variation of only $\pm$ 5% over 6 hours. Dew point maintained at 54°F. Complete automatic fire alarm and extinguishing system for all areas with central control panel indicators.

RCA Astro Electronics Division

Truly variable processing. Equipment is ideally suited for intelligence type data processing. The Random Access File is well suited for scientific problems. The Random Access File is EXTREMELY useful due to its independent searching capabilities in language translation, general non numeric information retrieval system, and engineering table look up work.

Procedures have been adopted for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage.

Initial experience in using this equipment for scientific research has been eminently successful.

Ordnance Weapons Command

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage includes putting visible labels on reels and tape labels at beginning of tape. An alarm bell set for 4 degree rise in temperature. An alternate storage site is used for one previous generation of reference, transaction and program library tapes.

Tape station substitution between Off & On-Line is a few minutes, which minimizes down time due to tape station malfunction.

Air-conditioning is for the area with no direct ductwork to the equipment.

Alarm permits sufficient time to dump memory prior to shutting down equipment. An eight degree rise in temperature over a brief period will cause the computer to malfunction.

Atlantic City Electric Company

Outstanding features include fast memory access time, solid state construction, variable format, punched paper tape output, high speed paper tape input, dual recording in magnetic tape and self checking circuits.

Unique system advantages include complete elimination of punched cards, printing of address side of utility bill simultaneously with billing information side, after which bill is folded and heat-sealed into postcard weight form. Automative reentry of cash through optical scanning of heat-sealed stubs with results punched into paper tape.

Adopted procedures for magnetic tape labelling and storage include tapes stored vertically in racks in partitioned area with full humidity and temperature control. Self-adhesive color-coded labels for identification.

Raytheon Company - Missile Systems Division

Outstanding features include true variable item length, which decreases tape passing time, low start-stop time (3.5 mil sec) which decreases tape passing time, dual recording which eliminates r/w errors, an octal numbering system, which conserves memory, and forward/backward read on tape.

Unique system advantages include a fully transistorized system, built-in modifiers (7), building block concept allowing future expansion of system, read/write and read or write/compute simultaneously feature, built-in controls (parity checks, arithmetic checks, etc), and forward/backward read.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include a CO_2 foam automatic fire detection and extinguishing system, a humidity control with air conditioner, and all magnetic tape storage in a separate "tape room".

FUTURE PLANS

U.S. Naval Propellant Plant

It is proposed that when the cost of overtime operations exceeds the rental fee of an on-line high-speed printer, a printer will be rented. Additional tape stations may be added to accommodate additional applications.

Scott Air Force Base

At the present time, we plan to put the reporting and accounting system for Commercial Service Authorizations on this system by 15 June 1960.

Mitchel Air Force Base

Short Range Plans.

Acquisition of tape switching unit Model 547-6. This is a manually controlled switching device. It is capable of switching from one to six predetermined tape station trunks to from one to six predetermined machine trunks by means of relay switching.

Re-engineering of systems design and programs for greater machine efficiency.

New applications.

Using the data in the Master Personnel Tape, qualitative selection of personnel for specific assignments is being studied. As a corollary to a computer selection would also be determination as to type of military order required and production of the order via computer.

Possible acquisition of a small computer which would replace present off line printer as well as provide for faster data input to 501 System via magnetic tape.

Elimination of card transcriber and reliance upon paper tape input for all transactions against the Master Personnel File.

Long Range Plans.

Possible acquisition of character recognition equipment. This equipment would "read" documents and the data would be placed on magnetic tape ready for processing by the computer.

Increased use of the computer to act as a personnel clerk making determination as to personnel actions (orders, reassignments, discharges, etc.) to a larger extent than is presently being done.

Use of the computer as an aid in performing operations research programs for management decisions. We envision the computer to be used in the areas of work measurement and the establishment of work standards, the analysis of present and projected personnel actions, particularly in the area of manpower requirements and assignments, etc.

Inclusion of our data processing system into the USAF combat logistics network (COMLOGNET).

Fidelity-Philadelphia Trust Company

On 1 February 1961, we will add 2 Burroughs MICR Sorters plus a converter from the sorters to the computer. After the Regular Checking Accounts are fully converted, plans will be made to convert Trust Department Accounting, Savings Accounts, Payroll, Commercial and Collateral Loans and Mortgages from Punched Card Systems to the Computer.

State Farm Life Insurance Company

Programming of all printing being arranged for ease in moving to off-line printer.

"System" designed for "bi-product" production of input paper tape in remote regional offices--but will be pioneered with all input tapes produced in Home Office.

Ultimately plan to move all present punched card work to RCA 501 eliminating all punched card equipment.

RCA Service Company - E D P Sales Dept.

Present plans call for installation within one year of a 2nd basic RCA 501 or advanced system together with additional off-line equipment.

There will also be available complete system design and programming services available on a contract basis, with and without computer operation.

RCA Astro Electronics Division

Additional tape stations and verification equipment, and additional modules of memory equipment for expanded applications will be required.

Ordnance Weapons Command

Investigating possibility of substituting an RCA-301 for off-line equipment. Complement to include a card reader, card punch, printer and two (2) tape stations. This should result in a rental savings of approximately $4,000 per month. This would serve to reduce main computer time since sorting could be done on the 301. It would also provide random access for special interrogations, precluding interruption of main frame production operations to satisfy the interrogations. No conclusive decisions have yet been reached, however.

Additional tape stations (7) will be added when production requires. (Approximately 1 year)

A modification of the paper tape reader will permit reading of eight (8) channel paper tape in addition to the present seven (7) channel.

Future applications to be programmed using RCA's Common Business Oriented Language. This will materially reduce both programming and debugging time.

Atlantic City Electric Company

It is anticipated that the RCA 501 equipment will be adequate for present applications and expected growth for at least the next ten years. Future applications may be continuing Property Records, Meter and Pole History Records, Personnel History Records and Engineering Studies.

Raytheon Company - Missile Systems Division

Planned applications include:

Inventory control for raw material, finished parts, max-min items and peculiar parts, covering initial inventory, cycle counts, required orders, and P. O. receipts, S. O. receipts, issues, adjustments, and transfers in order to provide transaction costs, in-process cost, stock status, and order analysis.

Shop order system covering process sheet preparation, material and labor explosion, and shop order initiation in order to provide S. O. progress reports and labor and material status reports.

Financial control of labor, material, and overhead in order to provide payroll and labor distribution, contract status reports, indirect labor expense, cost of work in process, and miscellaneous accounting reports.

When capacity is reached, the on-line printer will be changed for off-line equipment.

New equipment for future growth might include a 301 system for off-line card and tab effort.

INSTALLATIONS

U. S. Naval Propellant Plant
Indian Head, Maryland

AACS DCS/Compt/Stat Services Division
Scott Air Force Base, Illinois

Air Reserve Records Center
~~3800 York Street~~
Denver 5, Colorado

Ordnance Weapons Command
Rock Island, Illinois

Ordnance Ammunition Command
Joliet, Illinois

Atlantic City Electric Company
1600 Pacific Avenue
Atlantic City, New Jersey

EDPD - New York Electronics System Center
45 Wall Street
New York, N. Y.

Fidelity-Philadelphia Trust Company
135 S. Broad Street
Philadelphia, Pennsylvania

General Tire and Rubber Company
1708 Englewood Avenue
Akron 9, Ohio

Raytheon Company
Missile Systems Division
Haverhill Street
Andover, Massachusetts

RCA Astro Electronics Division
P. O. Box 800
Princeton, New Jersey

RCA Electronic Data Processing Division
Camden, New Jersey

RCA Electronic Systems Center
Cherry Hill Plant
Rte 38 & Haddonfield Road
Merchantville, New Jersey

RCA Service Company
EDP Administration, Cherry Hill
Camden 8, New Jersey

RCA Service Company
Electronic Data Processing Sales Department
Cherry Hill, Camden 8, New Jersey

State Farm Life Insurance Company
112 East Washington Street
Bloomington, Illinois

Bureau of Naval Weapons
18th & Constitution Avenue, N. W.
Washington 25, D. C.

Chase Manhattan Bank
57 William Street, Room 200
New York, N. Y.

Educational Testing Service
20 Nassau Street
Princeton, New Jersey
(Installation Rosedale)

RCA 601

Radio Corporation of America 601

MANUFACTURER

Radio Corporation of America
Electronic Data Processing Division

APPLICATIONS

The computer is a general-purpose, stored program, digital device utilizing transistor and diode circuitry. It provides high-speed storage, processing, and on-line input-output device control capabilities.

The 601 System is able to handle simultaneous routines. The number of such routines is not fixed but is a function of the speed-weight of any peripheral devices involved and the complexity of the individual routines.

In general, minimum storage capacity and complexity is required in external buffers due to maximum use of the internal memory under control of programmed routines. This permits flexible and economical input-output buffering to be achieved.

Computers may also be coupled together. This permits various multi-computer configurations to be obtained. Each computer may be oriented to some particular function, such as input-output processing, or may be completely general purpose in nature.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary, Binary Coded Decimal Alphanumeric
Binary digits/word	6, 8, 12, 16 or Variable
Binary digits/instruction	Variable 24 to 144
Instructions per word	Variable size instructions from 1/2 word to 3 words each
Instructions decoded	Variable over 120
Arithmetic system	Flo point, dec and bin (optional) Fix point, dec and bin (optional) Variable word length Operands limited by memory size
Instruction type	Number of address is variable. One, two, three address at programmer's option.
Number range	Depends on memory size
Instruction word format	Binary digit count

1	3	6	3	3	9	3	1	3	4	1	16	3
PAR	TAG	Op Code	D Interrupt Set-Sense Tags	ACD Assumed Address	Count Sym Register No	Cl	PAR	TAG	Address Mod.	IND	Half Word Add.	Char Add

Automatic built-in subroutines are available. For example, automatic servicing of que table for input-output instructions. Calculation of weight-load of input-output devices. Sortable preparation of criteria address list as data is read in. Several operation codes have the effect of a subroutine, i.e., code convert provides conversion from one bit structure to another.

Automatic coding includes Automatic Assembler, RCA Narrator (COBOL), and RCA ALGOL.

Registers and B-boxes include 8 address modifiers.

1/2 word	1/2 word
Address Modifier	This modifies the Address Modifier

Additional op codes can be added by the programmer since the elemental operations of the op code are available to him.

ARITHMETIC UNIT

Operation	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	9.75	6 (fixed word 11+11 char)
Mult	13.75	10 (fixed word 11x11 char)
Div	28.75	25 (fixed word 11÷11 char)

Arithmetic speed is variable depending on arithmetic unit and instruction control units ordered.

Construction	Quantities of transistors, diodes, and magnetic cores used in the arithmetic unit depend on particular unit used. No vacuum tubes are used.
Arithmetic mode	Serial for variable length arithmetic Parallel for fixed length arithmetic
Timing	Asynchronous
Operation	Concurrent

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	32,768	523,288-3 bit digit	0.9-1.5
	Variable	393,216-4 bit digit	
		262,144-6 bit digit	
		196,608-8 bit digit	
		Number of bits per digit is optional with programmer (3, 4, 6 or 8)	

Memory is in modules of 8,192 words. Use of more than one module permits overlap reducing access time to 0.9 microsec.

Word length is also completely variable if desired.

All magnetic tape units (22K, 33K, 66K) available with the 501 System are also available with the 601 in addition to that described here.

Eight bit code is Field at a 3.

Magnetic Tape

No. of units that can be connected	64 Units
No. of characters/linear inch	800 Chars/inch
Channels or tracks on the tape	10 Tracks/tape
Blank tape separating each record	0.9 Inches
Tape speed	150 Inches/sec
Transfer rate	120,000/180,000 Chars/sec
Start time	6 Millisec
Stop time	6 Millisec
Average time for experienced operator to change reel of tape	45 Seconds

Physical properties of tape

Width	3/4 Inches
Length of reel	2,400 Feet
Composition	Mylar

Hamming code check bits provide data reconstruction on each character on magnetic tape.

INPUT

Media	Speed
Paper Tape	1000 char/sec
Cards	600 cards/min
Magnetic Tape	120,000/180,000 22,222; 33,333; 66,666 char/sec
Teletype line	Up to 50 lines/min

Optional time scanning unit available.

Same magnetic tapes available on the RCA 501 are also available on the RCA 601. 22K and 33K tapes are interchangeable between RCA 601, 501, 301. 66K tapes are interchangeable between RCA 601 and 501.

OUTPUT

Media	Speed
Paper Tape	100 or 300 char/sec
Cards	100 cards/min
Magnetic Tape	120,000/180,000 22,222; 33,333; 66,666 char/sec
Printer	600 lines/min

Up to 6 magnetic tapes may be read simultaneously and up to 8 magnetic tapes may be written out simultaneously.

Up to 8 card readers may be operated simultaneously.

Up to 8 card punches may be operated simultaneously.

Up to 6 printers may be operated simultaneously.

On-line card readers, card punches and printers may be operated independently of program being run.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type

Transistors

3696	2N1495
3696A	2N1289
3697	2N581
3697A	

Diodes

8945076-B1	8512070-A5
8989190-B2	

Quantity depends on system.

The system consists of modules which are assembled in accordance with the requirements of the operation. For example the instruction control unit for floating point calculations and the high speed arithmetic unit are not normally included in a data processing configuration but could be if the customer required the additional speed.

PERSONNEL REQUIREMENTS

Personnel requirements vary in accordance with the complexity of the problem and the configuration of equipment.

Training courses made available by the manufacturer include systems analysis courses, programming courses, special purpose courses, and operators training.

CHECKING FEATURES

Accuracy control is accomplished in the RCA 601 system by the following methods:

General

Provision is made for utilization of error correcting code at points of higher error probability.

Extensive checking and indicating equipment is utilized at key points in the system to detect and facilitate rapid diagnosis of system error.

Error indication is made available to the program to permit self diagnosis and attempted correction of alarm conditions.

A large variety of programmed checking procedures are facilitated with features such as data tagging and real-time clock interruption.

Use of Error Correcting Code

It is generally recognized that electro-mechanical equipment is inherently more prone to error than completely electronic equipment. For this reason RCA 601 high-performance magnetic tapes are provided with the option of an error correcting code. An alpha-numeric character is then represented on tape by ten parallel bits. Six of these define a character. The remaining four bits are utilized to provide automatic correction of an error detected while reading a character from tape.

In the computer it is possible to utilize the two tag digits associated with each word as a six-bit word correction digit.

This feature is particularly effective when applied to micro-instruction routines stored in the high-speed memory.

Error Correction

An automatic half-word parity check is made at key points in the RCA 601 Computer during each data transfer. Some of the points checked are the input and output paths of the high-speed memory, arithmetic operand registers, output buffers, etc. The check points are selected to facilitate error diagnosis either manually or by program.

In addition to the above, a number of special error detecting circuits have been incorporated. These circuits may be divided into three classes.

Circuits which detect alarm conditions caused by the program.

Those which detect an error condition which may have been caused by either program or component malfunction.

Circuits that detect an error which could only be due to a component failure.

Alarm Indication

An alarm condition may be detected by the above checking circuits or by the program itself. In either case, an appropriate indicator is set upon detection of the alarm condition. Three alternatives are available when an indicator is set:

An immediate shut-down can occur

The indicator can be ignored

Automatic transfer of control to an auxiliary routine can be initiated.

In the latter case, the auxiliary routine can be used to analyze the alarm condition and:

Attempt correction by re-running the portion of the program in error, or

Bypass the alarm condition by means of an alternative program path, if available, or

Initiate a shut down if the alarm condition can neither be alleviated nor by-passed.

On-Line Considerations

Operating equipment on-line results in several advantages regarding system accuracy control:

More powerful, automatic, diagnostic techniques may be utilized by the computer than by most test equipment.

Time sharing the computer electronics results in less special-purpose hardware in which a failure can occur.

Alternate program paths can often be provided to permit equipment which is malfunctioning to be automatically by-passed.

Full advantage can be taken of the above on-line system characteristics in the RCA 601 System. If, for example, an operable alarm occurs upon connection to an on-line device, control can be automatically transferred to an auxiliary program.

Sufficient information is supplied to this routine so that an existent alternative path may be determined.

Accuracy control on specific components include:

Computer - Model No. 603 and No. 604

Special error detecting circuits provide machine malfunction alarms. In addition, a real-time clock, memory lock-out facilities, and other checking features permit the detection of a wide range of programming errors.

Magnetic Tape Transfer Channel - Model No. 610

Parity is checked or generated on all data which is received by or transmitted from the buffers. The 22K and 33K tape stations have dual track reading and recording. The 66K tape station has dual track reading and recording plus read after write. The 120/180K tape station has data reconstruction with 6 data bits and 4 check bits for each "character" position.

Magnetic Tape Transfer Channel - Model No. 611

Six bit characters in the write buffer are converted to 10 bit self-correcting code for recording on tape. When reading from tape, the 10 bit characters are converted back into six bit code for accumulation in the buffer storage. Special circuits provide automatic error correction for characters read from tape. A read-after write check is automatically executed when writing data into tape.

Parity is checked or generated on all data which is received or transmitted by the sub units.

Card Transfer Channel - Model No. 613

Read -- Each column of the card is read by two sensing stations, and the outputs of these stations are transmitted to the Card Transfer Channel where they are compared.

Punch -- Read after punch returns are checked against the information previously transmitted to the Card Punch.

Inquire Transfer Channel - Model No. 617

Parity is checked or generated on all half words received from or transmitted to the computer. Parity is checked on all characters received from the Inquiry Console.

Inquiry Console - Model No. 607

Indicators on the control panel indicate when criteria may be introduced into the system, when the computer is searching for the data, and when all the data has been typed.

Card Reader - Model No. 623

Each column on a card is read twice thereby facilitating a check of the reading operation by the computer. The Card Reader stops upon sensing a card jam, empty input hopper, full output hopper, or full reject hopper.

Card Punch - Model No. 634

Each card is read after it is punched, thereby facilitating a check by the computer on the punching operation. The Card Punch automatically halts when either the card supply is exhausted or the output hopper capacity is exceeded.

Magnetic Tape Station - Model No. 681

Remote lockout
Local lockout
Inoperable indication to user equipment

Tape station in local status
Power off
Servo off
Capstan motor off
Any transport mechanism interlock open
Improper amount of tape in bins

Automatic stopping of tape at end of reel
Write lockout
Read after write parity check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	Approx. 45 Kw Approx. 58 KVA
Power, air conditioner	Depends on air conditioner used Approx. 13 Tons
Volume, computer	275 cu ft
Area, computer	60 sq ft
Room size	1,000 sq ft, computer
	400 sq ft, service area
	1,400 sq ft, Total
Floor loading	100 lbs/sq ft
Capacity, air conditioner, computer	13 Tons
Weight, computer	Approx 1,900 lbs

System input must be supplied from a Y connected grounded neutral 3-phase source of 208 volts $\pm$ 10% at 60 cycles $\pm$ 1/2 cycle/sec.

False flooring is desirable for cable connections only.

All power, cooling and space requirements are subject to change and will vary from system to system due to the highly modular concept of the equipment.

PRODUCTION RECORD

A prototype is under construction.
Time required for delivery 18 Months
First deliveries will be in July 1961

ADDITIONAL FEATURES AND REMARKS

Flexibility of configuration and application by options in speed, size and op code.

Data and program security are enhanced when multiple programs are run.

Multiple computer systems can share memory.

COST, PRICE AND RENTAL RATES

Components of basic system

Model	Quantity	Data Processing System	Cost	Monthly Rental
603	1	Computer with 8,192 words of memory (65,536 alpha or 98,304 numeric Char), console and power supply	$ 839,700	$ 19,500
610	1	Tape Transfer Channel	26,100	580
640	2	Tape Switch	31,800	700
582	10	Tape station (66,666 char/sec)	432,600	8,750
632	1	On-Line Printer	32,200	700
612	1	Print Transfer Channel	23,600	515
623	1	Card Reader	15,850	350
613	1	Card Transfer Channel	11,300	250
		TOTAL	$ 1,443,150	$ 31,345
		Scientific System		
604	1	Computer with 8,192 words (98,304 numeric or 65,536 alpha chars) high speed arithmetic, console and power supply	$ 998,600	$ 22,300
661	1	Additional high speed storage (8192 words)	314,200	6,980
610	1	Tape Transfer Channel	26,100	580
640	1	Tape Switch	15,900	350
580	6	Tape stations (22,222 char/sec)	151,140	2,790
632	1	One-Line Printer (600 lines/min)	32,200	700
612	1	Print Transfer Channel	23,600	515
621	1	Paper Tape Reader	11,900	260
		TOTAL	$ 1,573,640	$ 34,475

Additional components

Model	Description	Cost	Monthly Rental
681	Tape Station 120,000/180,000 char/sec	$ 56,300	$ 1,080
580	Tape Station 22,222 char/sec	25,190	465
581	Tape Station 33,333 char/sec	29,700	550
611	Tape Transfer Channel for 681 (max. of 48 tape stations per channel)	76,800	1,670
641	Electronic Tape Switch (max. of 6 Tape stations per switch) for 681	36,100	785
614	DaSpan Coupler	13,200	290
615	Extensor scanner	25,500	565
616	Extensor	1,580	35
607	Inquiry Console	12,600	280
617	Inquiry Transfer Channel	11,700	260
634	Card Punch (100 cards/min)	8,900	200

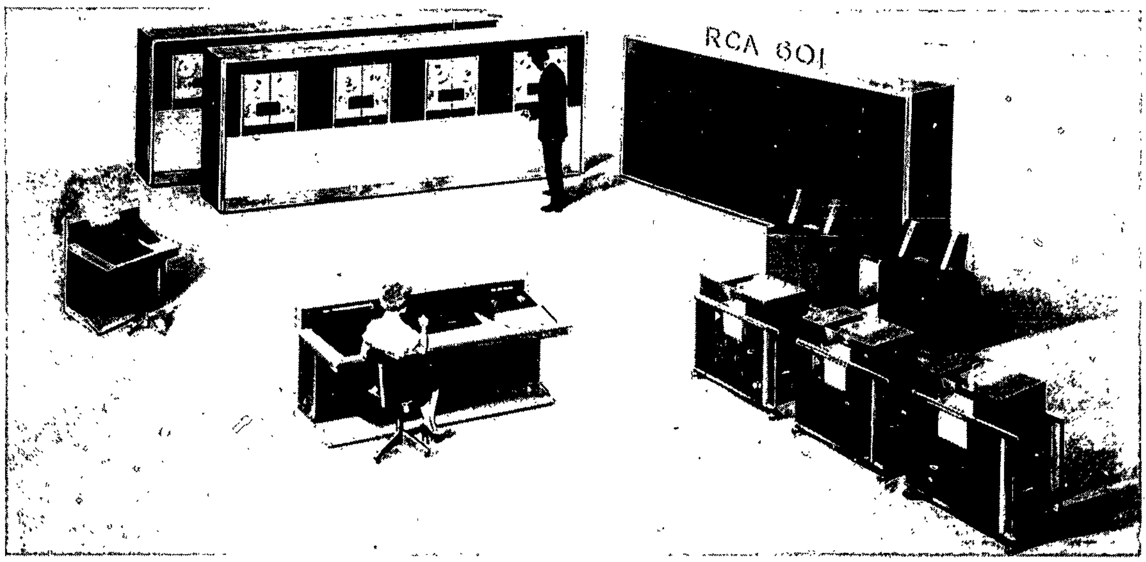


Photo by Radio Corporation of America

READIX

Readix General Purpose Computer

MANUFACTURER

Idaho Maryland Mines Corporation
Magnetics Division

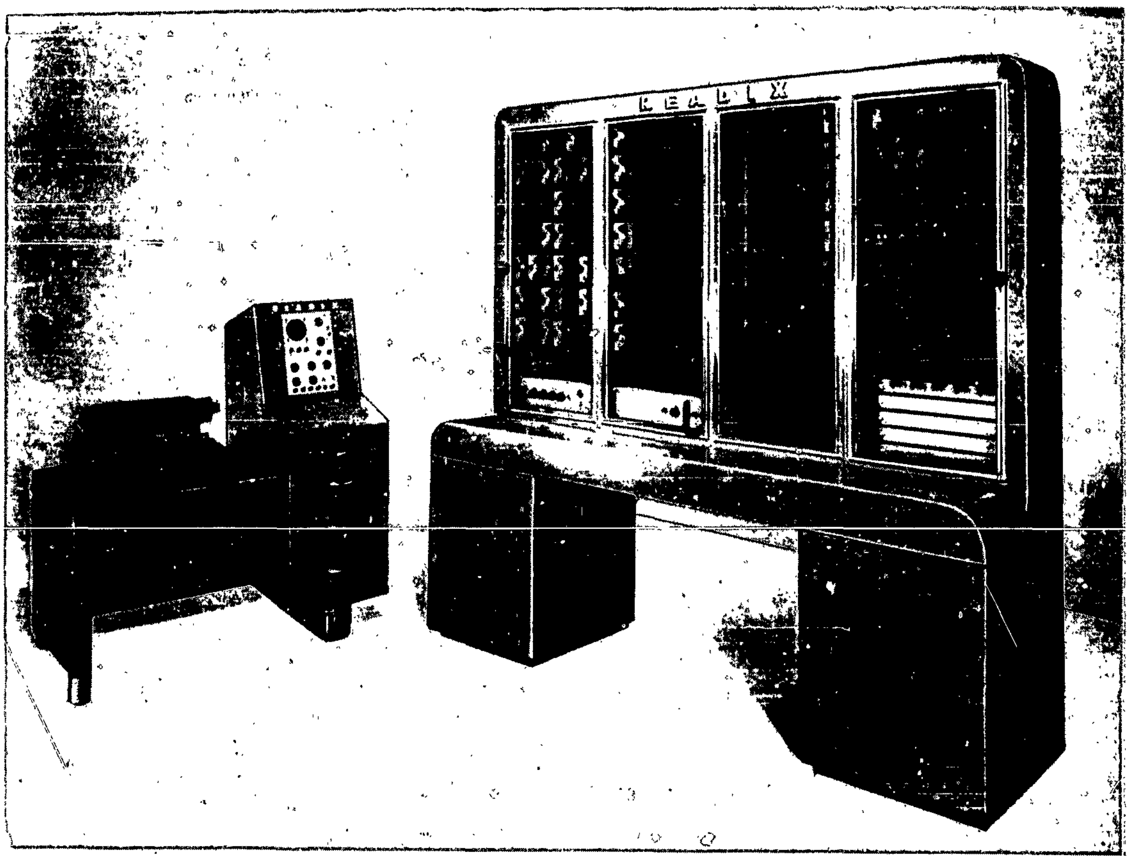


Photo by Magnetics Division, Idaho Maryland Mines Corporation

APPLICATIONS

Manufacturer
System is designed and used for scientific computation, commercial data processing, record keeping, and data reduction.

USAF Aerospace Technical Intelligence Center
Located in Building 828, Area A, at W-PAFB, Ohio, the system is used for performance calculations for aircraft and guided missiles.

U.S. Air Force Flight Test Center
Located at 125 South Grand Avenue, Pasadena, California, the system is used for the calibration of bombing range instrumentation including Askania Cinetheodolites, Mitchel and Bowen-Knapp Cameras, Fairchild Ballistic Cameras, and impact geophones and sound microphones; for the space positioning of military aircraft for performance studies and evasive tactics studies; and for the space positioning of bombs, and air-to-ground and air-to-air missiles; and for ballistic studies.

Science Research Associates, Inc.
Located at 104 Pearl Street, McHenry, Illinois, the system is used for score conversions and statistical correlations.

Universal Research and Testing Laboratories
Located at 1733 Flower Street, Glendale, California, the READIX II is used for engineering applications, including control and timing of test set-up's (with the use of an Analog-Digital Converter), for scientific and engineering problems, and for numberical analysis. The business applications include anticipated usage for accounting problems, production control, and for a Service Bureau.

Applications include digital techniques in statistical analysis of experiments, feedback control system design considerations, and selection of method of synthesis for feedback controls. Feedback system compensation applications include design criteria and techniques, compensating components: D-C Systems, compensating networks: A-C Systems, and open-closed loop control. Studies of measurement of noise, system response to noise, system design in the presence of noise, and random variable concepts have also been made. Applications also include general nonlinear system problems, control and timing of test set-ups, analysis of general sys-

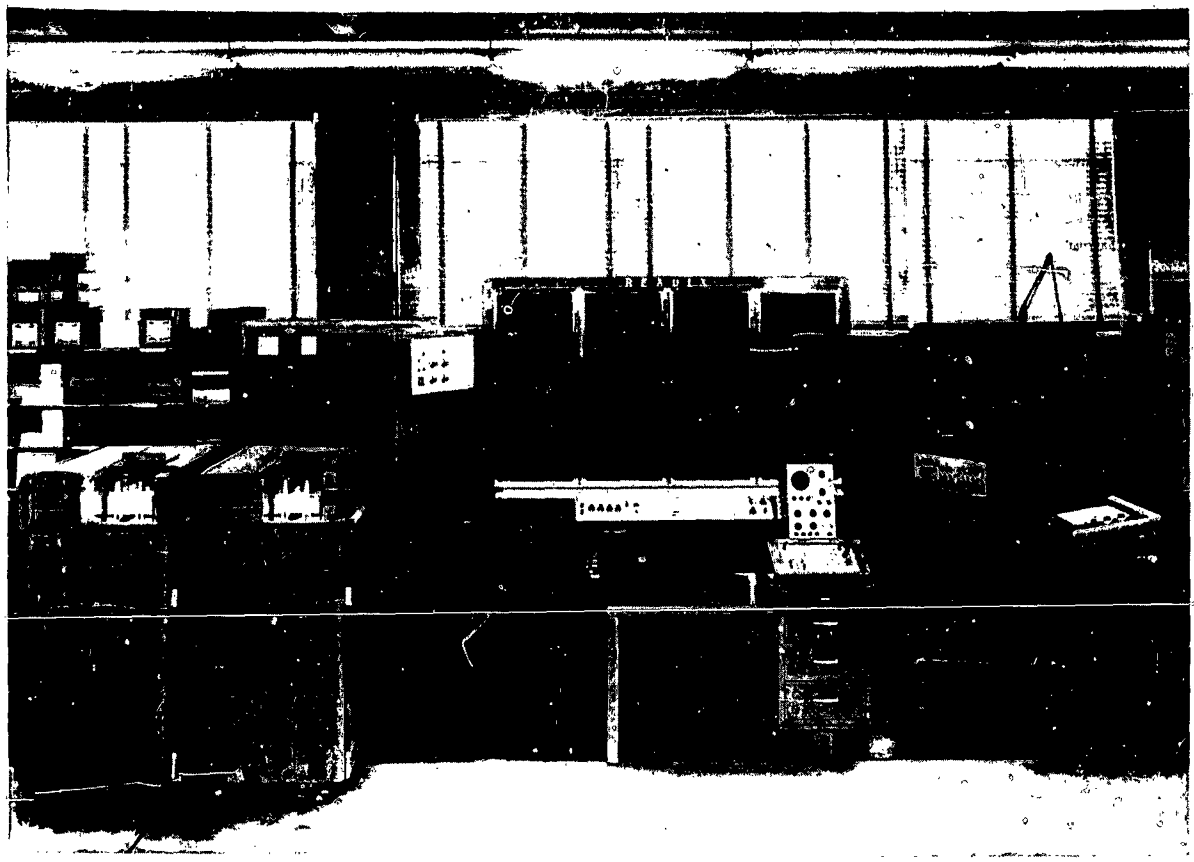


Photo by Universal Research and Testing Laboratories

tems, designing for reliability, component characteristics, and transistor circuits.

Other applications include
  Facility Requirements
    Physical Installation
    Personal Requirements

  Accounting Applications

  Design of Business Systems

  Inventory and Scheduling Application
    Inventory Control
    Aircraft Production Scheduling

  Scientific and Engineering Applications
    Simultaneous Linear Algebraic Equations
    Characteristic Roots and Vectors
    Linear Programming
    Differential Equations
    Statistical Analysis

  Techniques for Reliability
    Summary of Operating and Design Techniques
    System Design
    Circuit Design
    Maintenance

  Logical Design
    Algebraic Techniques of Logical Design
    Preliminary Design Considerations
    Detailed Logical Design

  Arithmetic and Control Elements
    System Considerations
    Binary Operations
    Decimal Operations
    Control Elements

  Random Variables and Distribution

  Operations Research
    Operations Research and Mathematical Mod.ls
    Data for Testing
    Controlling the Solution

  Numerical Analysis
    Interpolation, Curve Fitting, Differentiation, and Integration
    Inversion and Simultaneous Linear Equations
    Digital Techniques in Statistical Analysis of Experiments
    Ordinary Differential Equations
    Partial Differential Equations

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Decimal digits/word	Ten plus sign
Decimal digits/instruction	5
Arithmetic system	Floating point
	Add, subtract, multiply and divide
	Fixed point
	Add, subtract, multiply, divide, and square root

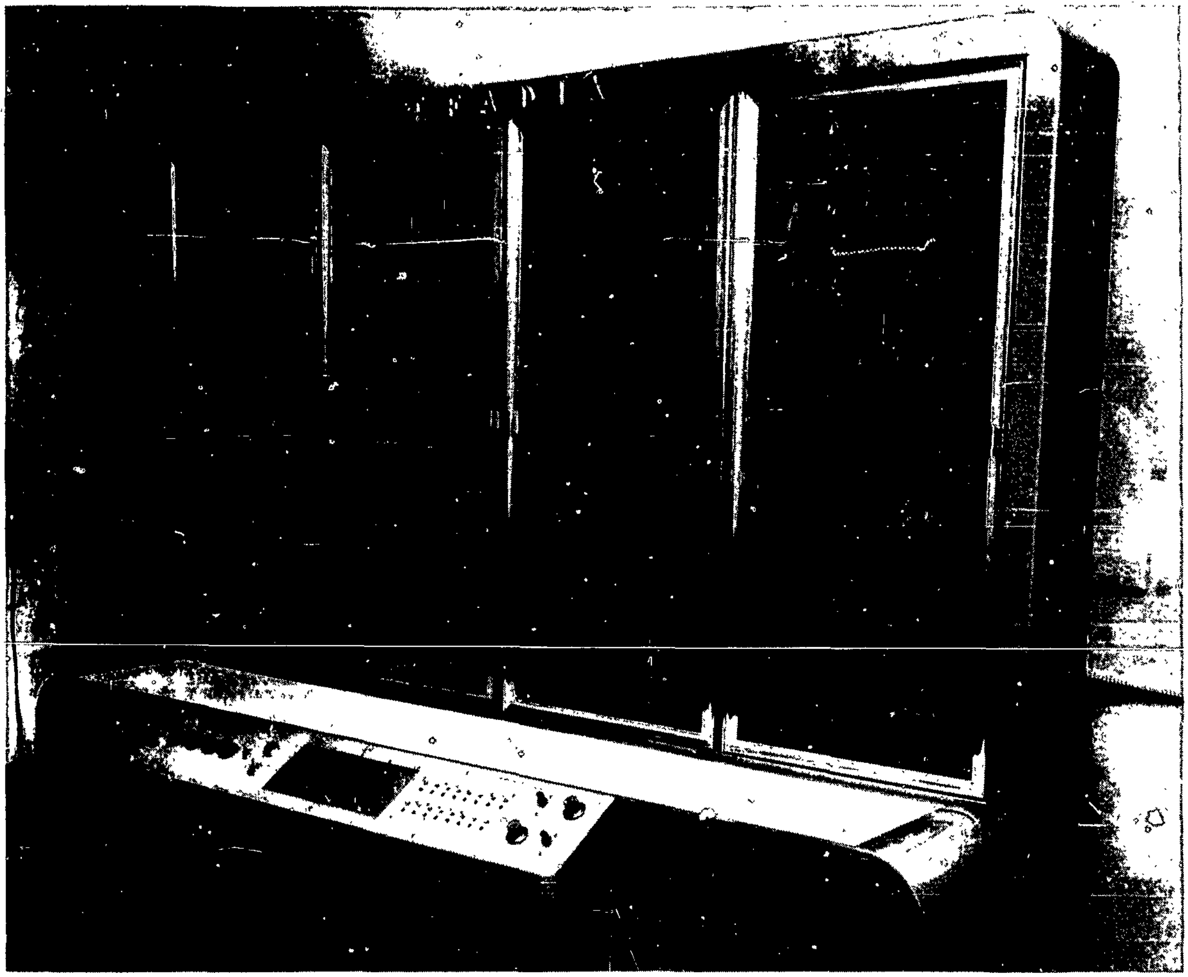


Photo by U.S. Air Force Flight Test Center, Edwards AFB

Instruction type One address Stored Program
Number range Fixed $\pm(10^{10}-1)$
Floating $\pm(10^{+49}_{-50}-1)$

Instruction word format

1 2	3 5	6 7	8 10
Operation	Address	Operation	Address

Automatic built-in subroutines include square root.

Registers and B-boxes include 4 One-word arithmetic registers (S, T, U, and V) and a B-box with automatic address modification.

ARITHMETIC UNIT

Operation	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	440	440
Mult	25,000	16,000
Div	40,000	24,000

Construction (Arithmetic unit only)
Vacuum-Tubes 80 (5687)
Condenser-Diodes 1200 (1N116 Hughes) Germanium
Arithmetic mode Serial
Timing Asynchronous
Operation Sequential

Photo by U.S. Air Force Flight Test Center, Edwards AFB

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	4,000	40,000	8,000 avg
Magnetic Drum	160	1,600	4,000 avg
Register	5	50	220 avg

Magnetic Tape

No. of units that can be connected	10 Units
No. of chars/linear inch of tape	500 Chars/inch
Channels or tracks on the tape	5 Tracks/tape
Blank tape separating each record	1 Inch
Tape speed	60 Inches/sec
Transfer rate	1,000 Chars/sec
Start time	7 Millisec
Stop time	7 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Red oxide

USAF ATIC

Medium	No. of Words	No. of Digits	Access Microsec
Drum	4,000	40,000	17,000

Access time to working storage (160 words) is 1,700 microsec.

USAF AFFTC

Magnetic Drum	4,000	10 decimal	4,250
Quick Access Magnetic Drum	160	10 decimal	1,063

Science Research Associates, Inc.

Magnetic Drum	4,000	40,000	440

There are 40 words/channel and 100 channels.

Universal Research and Testing Laboratories

Magnetic Drum	4,160	41,600	4,000

Magnetic Tape

There are 150,000 words/reel or 1,500,000 digits/reel.

The magnetic tape is used as intermediate storage of digitized information from the analog to digital converter to the READIX computer.

INPUT

Manufacturer

Media	Speed
Flexowriter	10 char/sec
Paper Tape	60 char/sec
Cards (IBM)	100 cards/min
Magnetic Tape	1,000 char/sec
USAF ATIC	
IBM Card Reader	100 cards/min
Flexowriter	10 digits/sec
USAF AFFTC	
Keyboard (Flexowriter)	Manual
Paper Tape (Flexowriter)	10 char/sec
Paper Tape (Teletype)	60 char/sec
Science Research Associates, Inc.	
Cards	100 or 33.3 cards/min
Paper Tape (Flexowriter)	75 10-digit words/min
Universal Research and Testing Laboratories	
Keyboard (Flexowriter)	Manual
Paper Tape (Flexowriter)	12 char/sec
Cards (IBM)	100 cards/min

OUTPUT

Manufacturer

Media	Speed
Flexowriter Keyboard	10 char/sec
Paper Tape	60 char/sec
Cards (IBM)	100 cards/min
Magnetic Tape	1,000 char/sec
USAF ATIC	
IBM Card Punch	100 cards/min
Flexowriter	10 digits/sec
USAF AFFTC	
Printed Page (Flexowriter)	10 char/sec
Paper Tape (Flexowriter)	10 char/sec
Paper Tape (Teletype)	60 chars/sec
Science Research Associates, Inc.	
Cards	100 or 33.3 cards/min
Paper Tape (Flexowriter)	75 10-digit words/min
Universal Research and Testing Laboratories	
Paper Tape (Flexowriter)	12 char/sec
Cards (IBM)	100 cards/min

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity
Tubes	
5687	200
5963	38
6U8	14
6350	11
Diodes (Germanium)	
1N116	3,050
S49	1,010
1N100	15

CHECKING FEATURES

Manufacturer

Checking features include overflow, non-existent number (all decimal), non-existent instruction, non-existent address, and double decision.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	8 Kw
Volume, computer	68 cu ft
Area, computer	14 sq ft
Room size	14 ft x 14 ft
Weight, computer	1,750 lbs

Site requirements include a 100V, AC, 100 AMP Line. Ambient temperature should be no higher than 80° F.

USAF ATIC

Power, computer	5 Kw
Power, air conditioner	3 Kw
Volume, computer	180 cu ft
Volume, air conditioner	65 cu ft
Area, computer	40 sq ft
Area, air conditioner	8 sq ft
Room size	650 sq ft
Capacity, air conditioner	5 Tons
Weight, computer	1,750 lbs
Weight, air conditioner	400 lbs

System is mounted in a false floor. A central power box is installed. No special ducting for air conditioner is required.

USAF AFFTC

Power, computer	3.2 Kw	3.0 KVA	0.88 pf
Power, air condition	3.8 Kw		

2 - 1 1/2 ton window type

Volume, computer	1,373 cu ft
Volume, air conditioner	12 cu ft
Area, computer	78 sq ft
Area, air conditioner	12 sq ft
Room size	14 ft x 22 ft
Floor loading	18 lbs/sq ft
Weight, computer	1,400 lbs
Weight, air conditioner	250 lbs

The ceiling has been sound proofed with acoustical tile and a 7 1/2 KVA 3 phase and single phase power line was installed. No structural modifications were made.

Universal Research and Testing Laboratories

Power, computer	7.5 Kw
Volume, computer	156 cu ft
Area, computer	22 sq ft
Room size	14 ft x 14 ft
Floor loading	100 lbs/sq ft
	300 lbs concen max
Weight, computer	2,200 lbs

100 Amps at 115 Volts, AC, single phase line required. No other modifications were required.

PRODUCTION RECORD

Manufacturer

Number produced to date	6
Number in current operation	6
Number in current production	1
Number on order	1
Anticipated production rates	One/month
Time required for delivery	3 Months

COST, PRICE AND RENTAL RATES

Manufacturer

	Cost	Monthly Rental
READIX Computer (all decimal w/both fixed and floating point); 4,000 word drum; 107 instructions; desk console; Flexowriter, power supply; ventilation system; component tester.	$70,000	$2,400
IBM Converter	20,000	600
Magnetic Tape	25,000	800

Service Costs

Engineer at Installation $12,000 per year

On Call Service $100 per call plus traveling expenses

USAF ATIC

Basic machine (power, logic, console) cost $55,000.

A Punch Card Converter cost $17,500.

$12,500 per annum for a full time maintenance man.

USAF AFFTC

Computer main frame, console including input-output units, and power supply, total cost is $80,000.

In shop maintenance and service contract back-up, total approximate cost is $7,900 per annum.

Universal Research and Testing Laboratories

Basic system $70,000

Punched card converter at $20,000

Rental contracting and rates for basic system

$50 per hour, including engineering assistance.

Rental rates for additional equipment

$30 per hour, including engineering assistance.

Maintenance is by on call service from manufacturer.

PERSONNEL REQUIREMENTS

Manufacturer

Training made available by manufacturer to user includes programming and maintenance.

USAF ATIC

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	2
Coders	0
Clerks	0
Librarians	0
Operators	1
Engineers	1
Technicians	0
In-Out Oper	0
Tape Handlers	0

Operation tends toward open shop.

Methods of training includes on-the-job training.

READIX is used in support of a BURROUGHS 205.

USAF AFFTC

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts		1
Programmers	1	1
Coders		1
Clerks	1	1
Technicians	1	2

One supervisor and one technician is assigned exclusively to the computer. Other personnel used are drawn from other areas as necessary.

Operation tends toward open shop.

Methods of training used includes classroom lectures and individual training in programming and operation.

Science Research Associates, Inc.

	Two 8-Hour Shifts
Supervisors	2
Programmers	2
Operators	2
Technicians	1

Operation tends toward open shop.

Universal Research and Testing Laboratories

	One 8-Hour Shift Used	Recommended
Analysts	1	1
Programmers	1	1
Operators	1	

Methods of training used included a normal two week course from manufacturer.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

All perishable components are mounted on plug-in boards (ease of replacement). As standard equipment the READIX contains two internal test panels which check the only six types of plug-in boards used in the logic and arithmetic sections.

Average uptime in the field is over 90%.

Two READIX computers have been in the field for over five years and are still computing successfully.

USAF ATIC

Good time 30 Hours/Week (Average)

Attempted to run time 35 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.85

Above figures based on period Jul 59 to Mar 60

Passed Customer Acceptance Test Feb 56

Time is not available for rent to outside organizations.

USAF AFFTC

Average error-free running period 6.0 Hours

Good time 35.0 Hours/Week (Average)

Attempted to run time 41.9 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.835

Above figures based on period 1 May 59 to 27 Apr 60

Passed Customer Acceptance Test 15 Feb 57

Time is not available for rent to outside organizations.

Science Research Associates, Inc.

Operating ratio (Good/Attempted to run time) 0.95

Time is available for rent to qualified outside organizations.

Universal Research and Testing Laboratories

Good time 32 Hours/Week (Average)

ADDITIONAL FEATURES AND REMARKS

Manufacturer

The READIX medium general purpose computer, with 107 commands, is easy to learn and to program.

Unique system advantages include ease of maintenance. The READIX is most suited for scientific problems.

USAF ATIC

System is considered to be an excellent machine for small problems.

USAF AFFTC

Outstanding features include built-in floating point arithmetic, 9 external switches, program checked, and static and dynamic test equipment built into the computer. Manual procedures only for temperature, humidity and fire control have been adopted for the safeguarding of magnetic tapes.

Maintenance and spare parts provided locally.
Science Research Associates, Inc.
Outstanding features include large capacity memory.
Universal Research and Testing Laboratories
Outstanding features include floating point and fixed point, all decimal, large memory and large command list. Unique system advantages include ease of programming, operating, and maintaining.

FUTURE PLANS

Manufacturer
Transistorizing flip flops and memory plug-ins would make the READIX a solid state machine. Changing the working storage (160 words) to core would speed the READIX 2 to 5 times. 600 cards/minute input. Condense the size of READIX to the size of a desk.
USAF ATIC
By December 1960 ATIC will be operating a large 7090 system for both engineering and information storage problems and the READIX system will be phased out.
USAF AFFTC
Additional components planned are a punched card converter and associated card handling equipment.

INSTALLATIONS

United States Air Force
Air Technical Intelligence Center
Wright-Patterson Air Force Base, Ohio

Data Reduction Section
Air Force Flight Test Center
125 South Grand Avenue
Pasadena, California

General Electric Company
13430 No. Black Canyon Highway
Phoenix, Arizona

Science Research Associates, Inc.
104 Pearl Street
McHenry, Illinois

Universal Research and Testing Laboratories
4310 San Fernando Road
Glendale 4, California

RECOMP I CP 266

Recomp Model I
(Formerly designated CP 266)

MANUFACTURER

Autonetics Division
North American Aviation, Incorporated

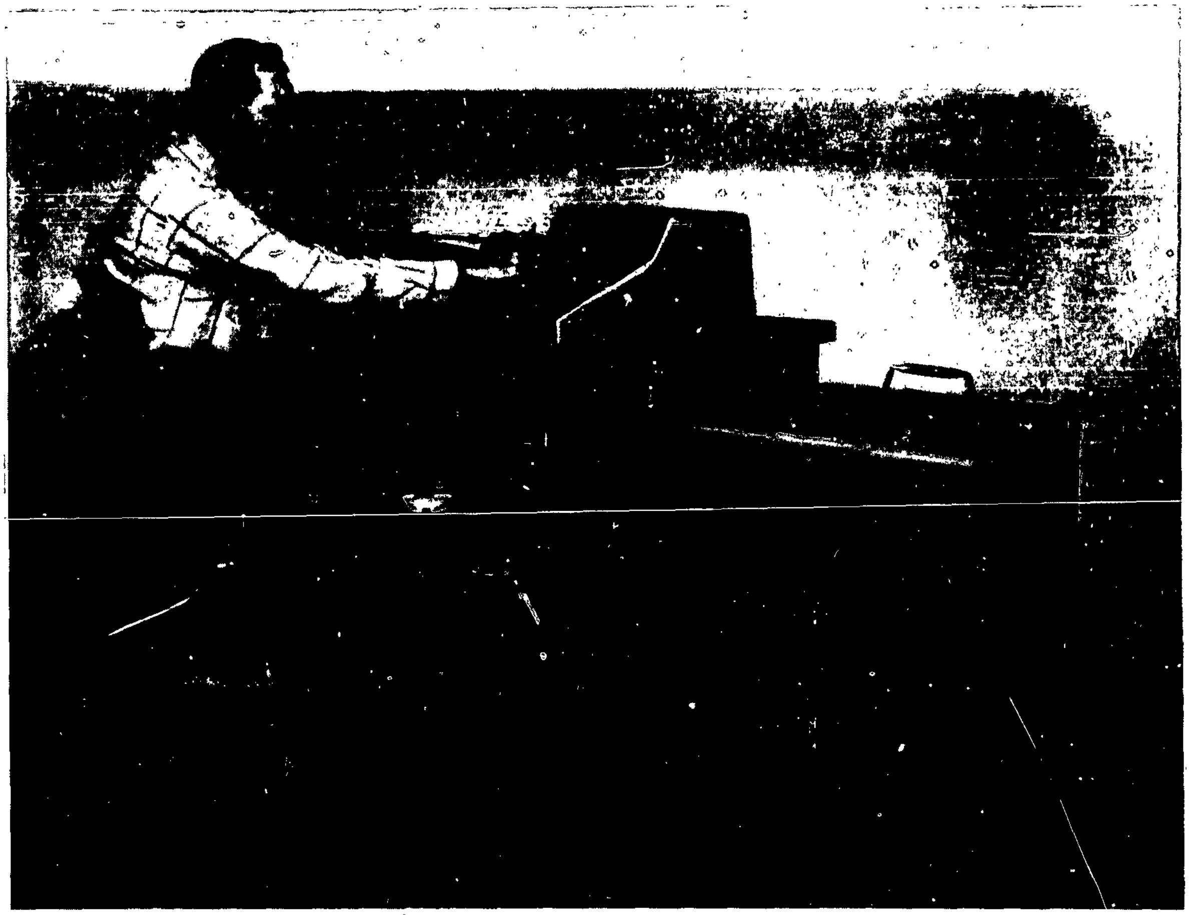


Photo by Autonetics Division, North American Aviation, Inc.

APPLICATIONS

Scientific computing and data processing for laboratory, field or mobile use.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	40
Binary digits per instruction	20
Instructions per word	2
Instructions decoded	34
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-(2^{39} - 1)$ to $+(2^{39} - 1)$

Three commands are provided in order to simplify "floating point" operation.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	2,000	1,000
Mult	21,000	20,000
Div	21,500	20,500

Construction	Transistors
Rapid access word registers	4
Arithmetic mode	Serial
Timing	Synchronous

Computer clock pulses are recorded on magnetic memory disc.

Operation	Sequential

Access time above is based on minimum access time. Transistors are used throughout. No vacuum tubes or magnetic amplifiers are employed.

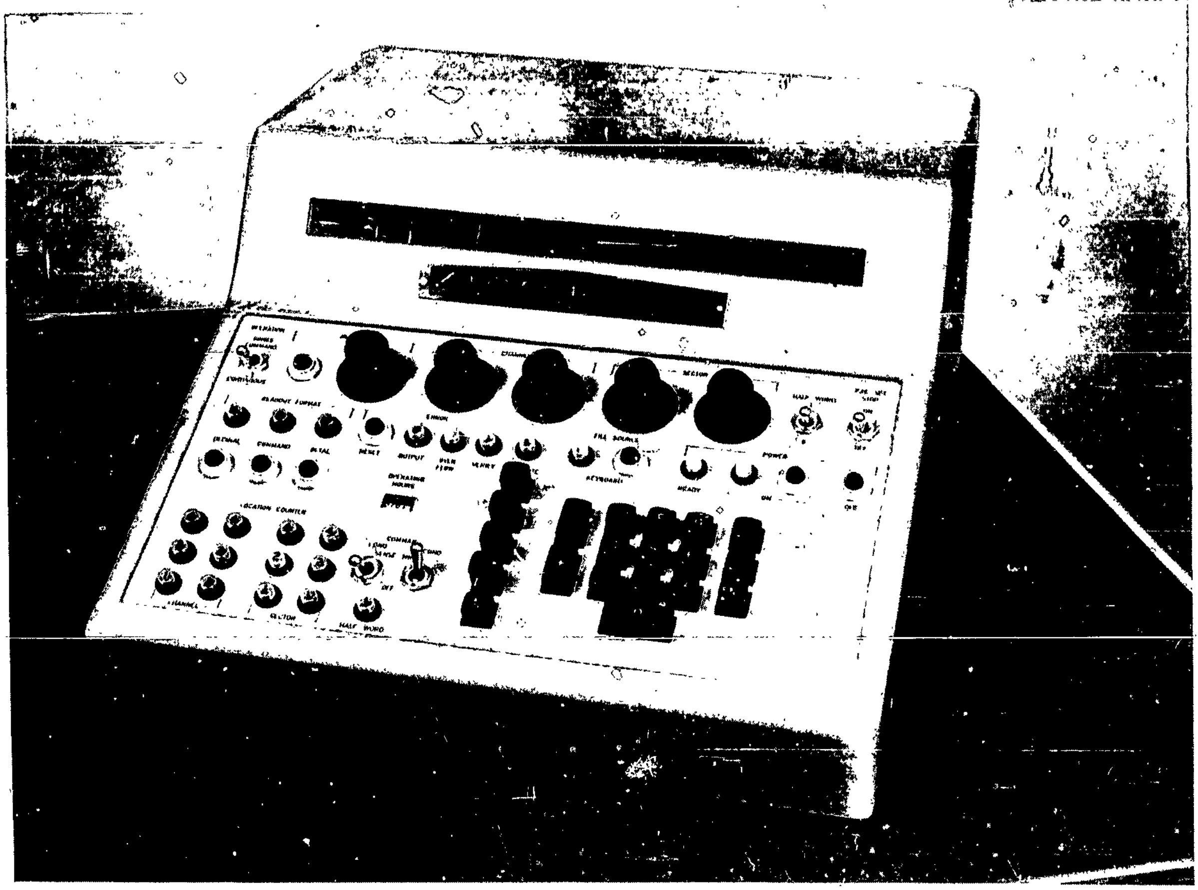


Photo by Autonetics Division, North American Aviation, Inc.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Disk	2,048	40	1,000-32,500
Magnetic Disk	16	40	1,000- 2,500

The 2,500 microsecond maximum access time for the high speed loop occurs on a read operation. The computer memory is of the rotating magnetic disk. A special air bearing maintains an extremely close spacing between the rotating disc and the optically precise headplate. The air gap sensed by the magnetic circuit is about 100 microinches wide. This highly efficient recording system has permitted pulse densities of 300 pulses per inch with write currents of 15 milliamperes.

INPUT

Media	Speed
Paper Tape Reader	37 char/sec
Decimal Keyboard	Manual
Electric Typewriter	Manual

Conversion of decimal mixed numbers to binary is wired in. Input process is automatically checked when the "verify" feature of computer is used.

OUTPUT

Media	Speed
Paper Tape Punch	10 char/sec
Decimal Readout Panel	66 millisec/dig
Electric Typewriter	Manual

All output errors are automatically detected using "echo" checking feature of computer.
Up to 15 decimal digits plus sign may be displayed on the Decimal Read-Out Panel.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Crystal diodes	7,000
Transistors	1,600

Standardized etched (printed) circuit cards.

CHECKING FEATURES

Fixed
System contains self-checking features designed to eliminate input-output errors. System has an "input-verify" feature and an "output-echo" checking feature.

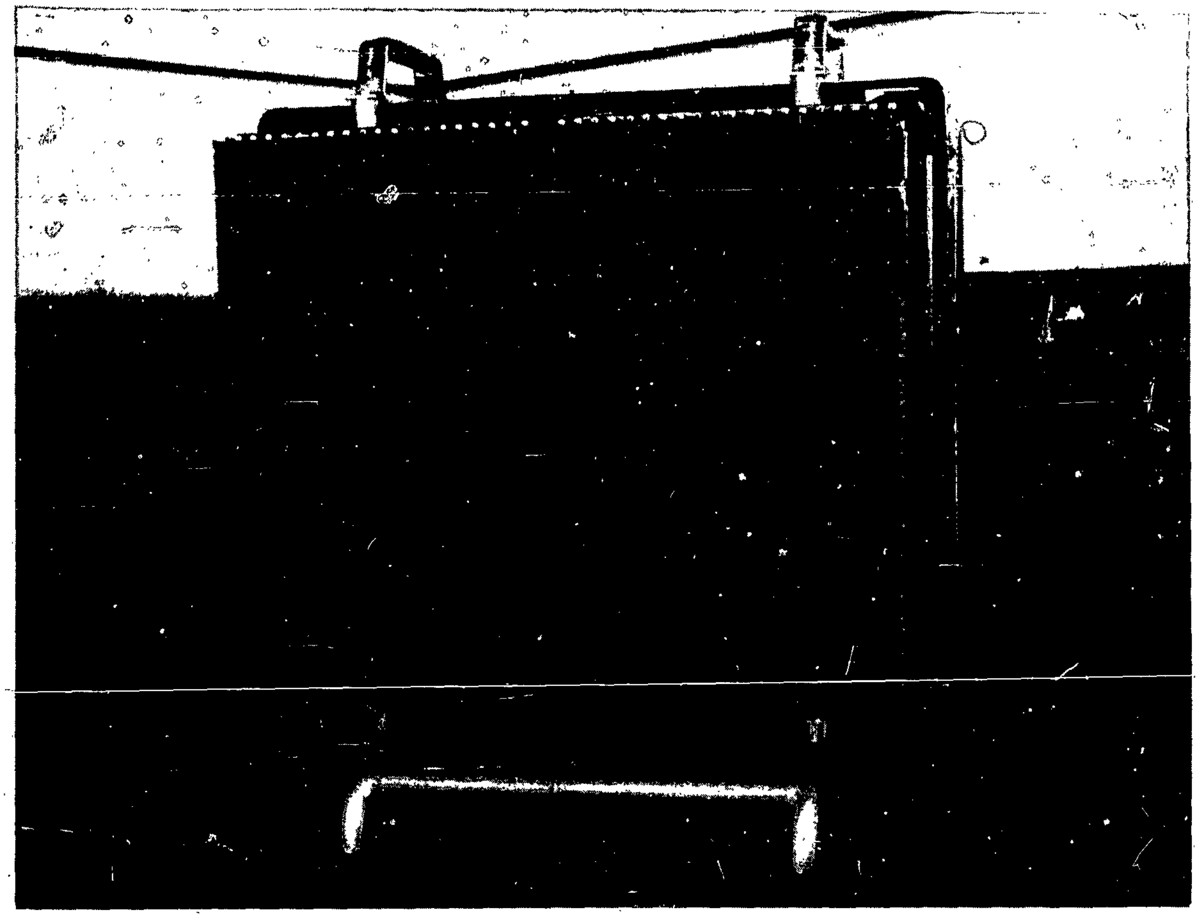


Photo by Autonetics Division, North American Aviation, Inc.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.3 Kw	0.3 KVA
Power, air conditioner	0.3 Kw	0.3 KVA
Volume, computer	5.7 cu ft, including air conditioner	
Size, computer	19.5 in x 23.5 in x 21.5 in, excluding typewriter and paper tape units	
Weight, computer	200 lbs	

Power requirement figures exclude typewriter and paper tape units. Air conditioner is built into computer package. Voltage regulated power supply is included.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

PERSONNEL REQUIREMENTS

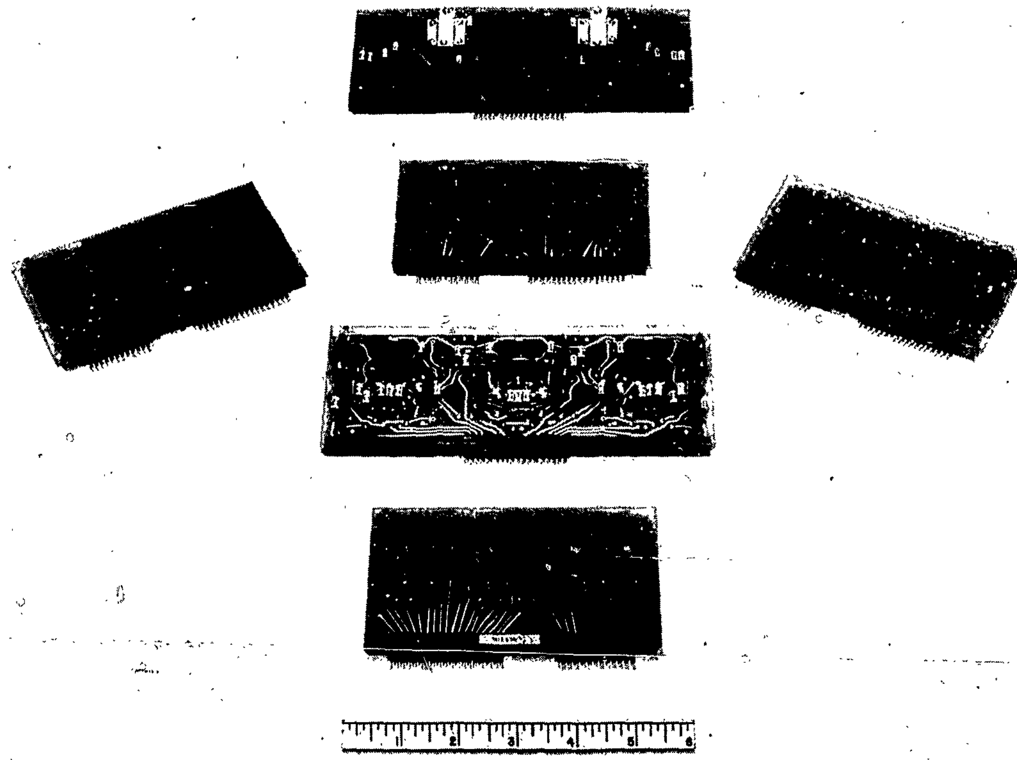
One operator per shift is required. Computer is designed for simple operation. Inherent reliability and test equipment make computer easy to checkout and maintain.

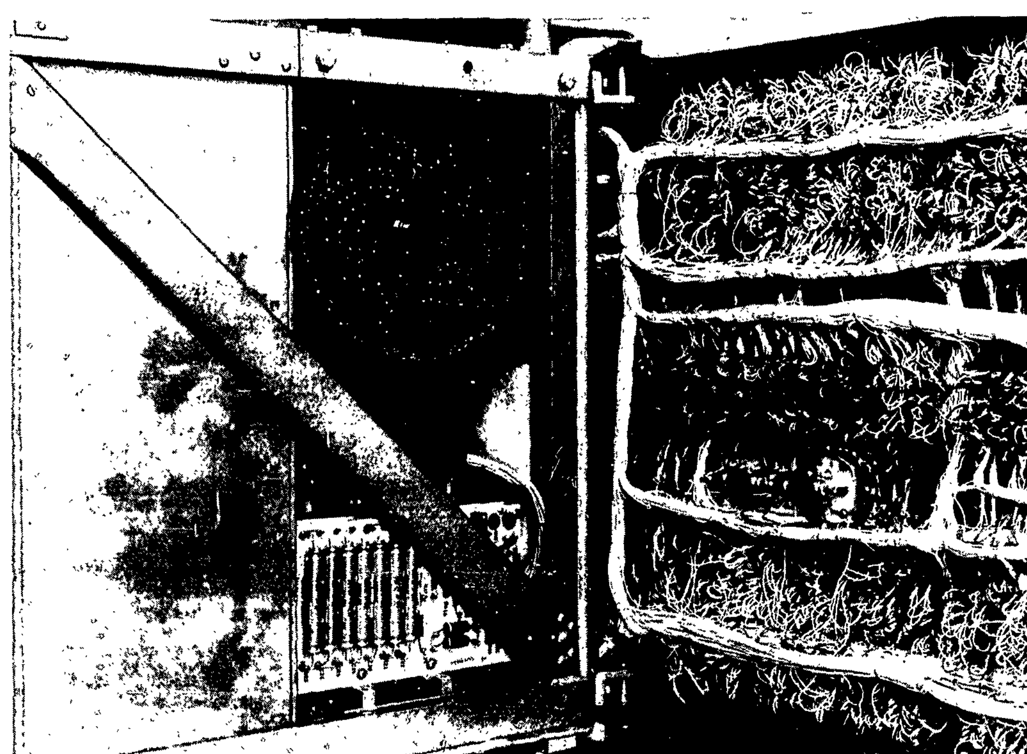
RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

All circuits and components used are designed to meet environmental conditions of the field, including continuous operation in 120° F ambient, vibration, humidity, etc.

ADDITIONAL FEATURES AND REMARKS

A checkout console is plugged into the computer, which makes it possible to rapidly check the complete computer system and its plug-in components. Outstanding features include small size, weight and power requirements for efficient use in office, laboratory or field. It is compact and rugged. System was developed by Reconnaissance Charting Branch, Intelligence Laboratory, Rome Air Development Center, under contract with Autonetics Division of North American Aviation, Incorporated.





Photos by Autonetics Division, North American Aviation, Inc.

RECOMP II

Autonetics Recomp Computer

MANUFACTURER

North American Aviation, Incorporated
Autonetics Division

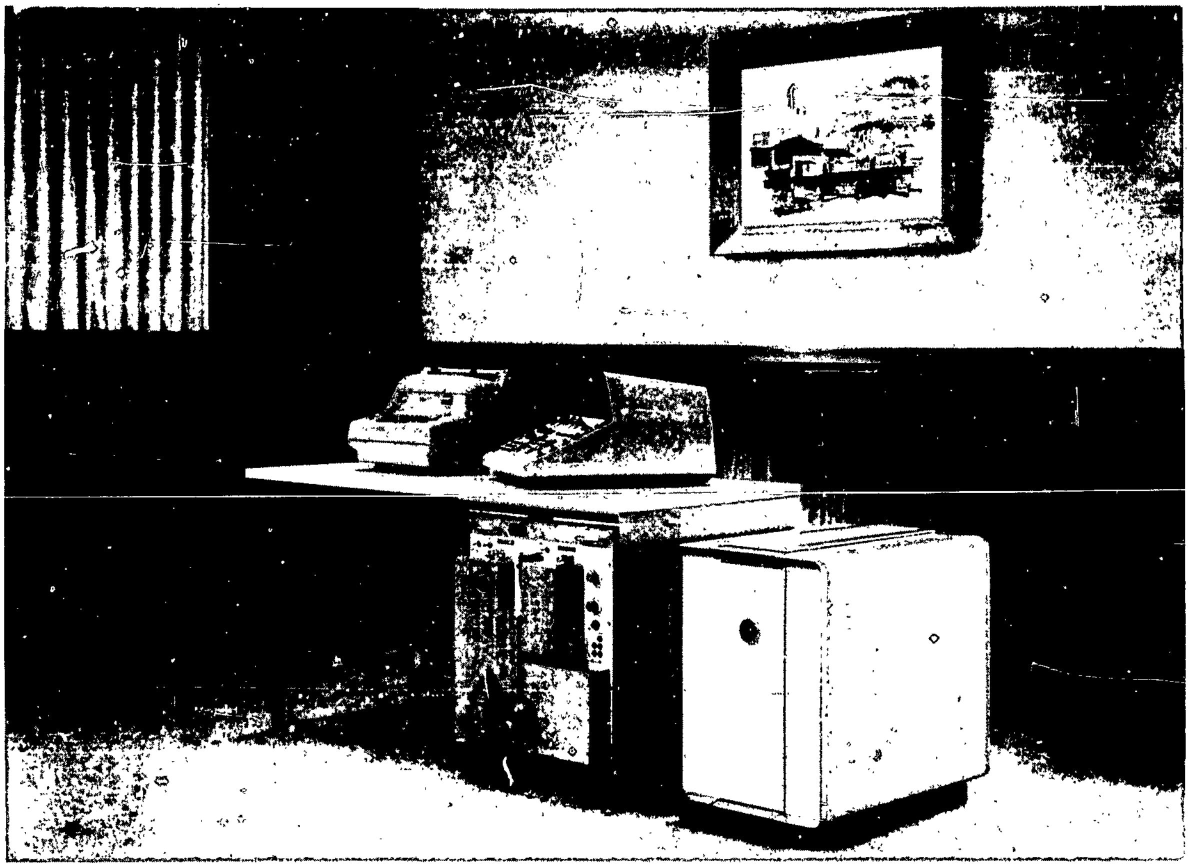


Photo by Autometric Corporation, Operations Division

APPLICATIONS

Manufacturer

RECOMP II is an all-transistorized general-purpose digital computer. This desk size computer does computations in mathematics, data reduction and analyses, optical engineering, photogrammetric calculations, operations research, and other civil engineering and scientific applications.

U.S.A. Combat Development Experimentation Center

Located in Building 2871, Fort Ord, California, the system is used for the analysis of field data from Combat Development Experimentation Center experiments and for the calculation of fire effects.

USASS ADPS OD

Located in Building 621, Fort Monmouth, New Jersey, the system is used by the Officers Department, ADPS Committee, U.S. Army Signal School, for the preparation of demonstration programs to illustrate the military applications of computer systems. These demonstrations include logistics and personnel accounting, radioactive decay calculations and fire control calculations. It is also used for the training of programmers.

USASS CONARC Briefing Team

On tour, the system is used by the USCONARC ADPS Briefing Team, U.S. Army Signal School, to demonstrate military applications of a digital computer to military audiences throughout the United States.

USASS Special Training Department

Located at Myer Hall, Dept. of Special Training, U.S. Army Signal School, Fort Monmouth, New Jersey, the RECOMP II in many respects is similar to the BASICPAC, a member of Army's FIELDATA family. For this reason, it can be and is being used for simulation for programmer training. It also demonstrates capabilities, limitations and applications during FIELDATA programmer, operator and maintenance training.

Offutt AFB

Located at the Offutt AFB, 544th Reconnaissance Technical Group, Analysis Center, the system is used for Geodesy (datum conversions; coordinate transformations; range and azimuths; geodetic position computations) and Photogrammetry (analytical triangulation; photo orientation and rectification).

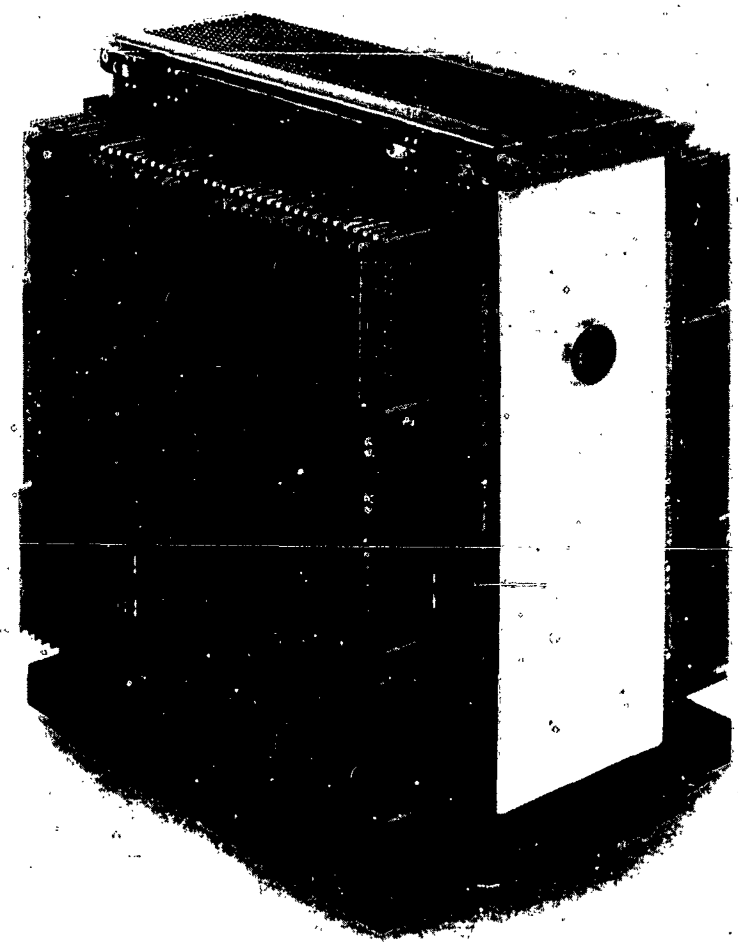


Photo by North American Aviation, Inc., Autonetics Division

Turner AFB
System is used in Geodetic Positioning, and Hiran distance computations. It is presently used to inverse, and position points and adjust these points to a most probable position. It is being programmed to do Hiran distance reduction computations.

W - P AFB
Located at the Institute of Technology (Air University), Wright-Patterson Air Force Base, Ohio, the system is used for training USAF officers in use of computers. It is used also for student and faculty research on problems of interest to the U.S. Air Force.

Autometric Corporation
System is used primarily to solve geodetic equations in aerial mapping and other branches of photogrammetry.

Melpar, Inc.
Located at 11 Galen Street, Watertown, Massachusetts, the system is used for radar calculations, information theory problems, character recognition, and considerable matrix work (eigenvalues, etc).

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer	
Internal number system	Binary
For output	Binary Coded Decimal
Binary digits/word	39 + sign
Binary digits/instruction	20
Instructions per word	2
Instructions decoded	Will hold over 8,000 at one time (49 different plus 5 input-output variants)
Arithmetic system	Floating point Fixed point
Instruction type	One address (Single)
Number range	Fixed $(2^{39} - 1)$; Floating $(1 - 2^{39})$. $2^{(2^{37} - 1)}$ or $10^{\pm\text{Forty billion}}$

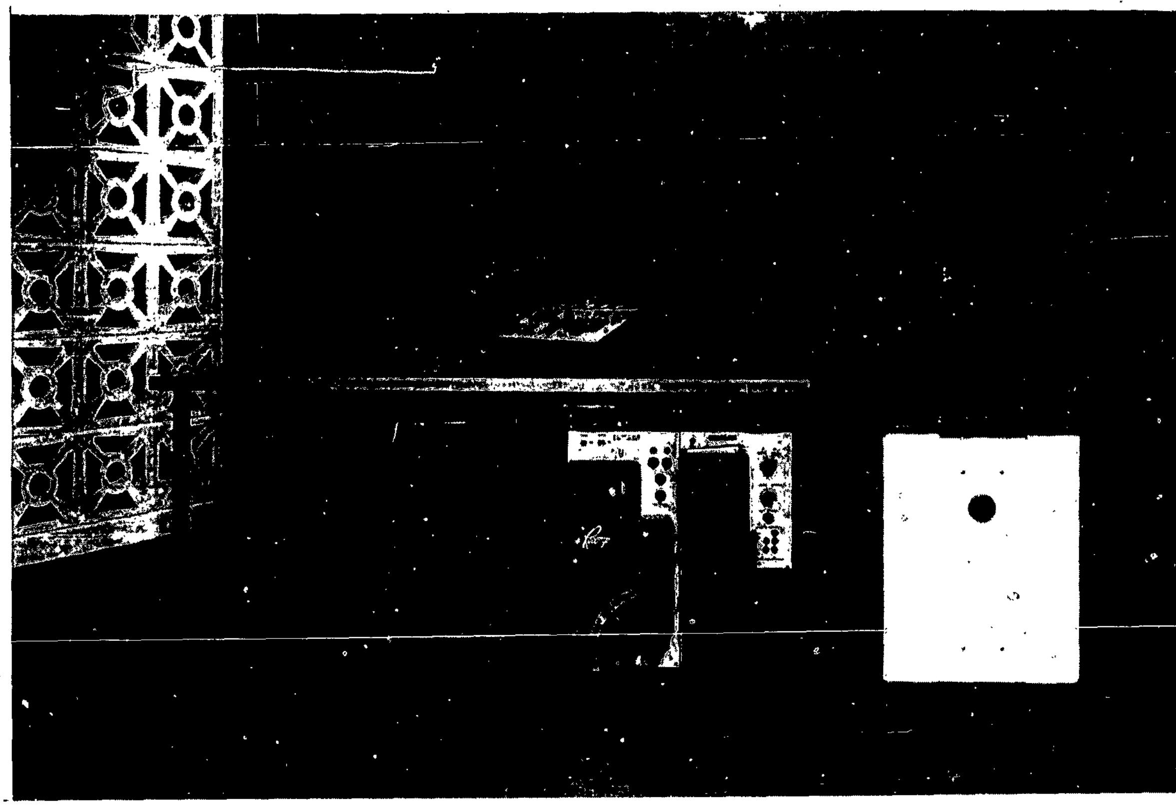


Photo by North American Aviation Inc., Autonetics Division

Instruction word format

Sign	OP	Address	Sign	OP	Address	
1	6	13	1	6	13	Bits

Automatic built-in subroutines include trapping on negative instructions, floating point operations, and fixed and floating square root. Assemblies and compilers are available.

There are four registers, designated A, R, C and B.

ARITHMETIC UNIT

Manufacturer

	Exclud Stor Access Microsec	
	Fixed point	Fixed point
Add	540	1,350
Mult	10,800	12,400
Div	11,300	12,700

Arithmetic unit is constructed of transistors.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Medium	No. of Words	No. of Decimal Digits
Magnetic Disk	4,096	49,000

Average access time is 9,000 microseconds for main memory and 900 microseconds for high speed memory. There are two high speed loops of 8 words each.

Melpar, Inc.

High-speed storage can hold 32 commands or 4 floating point numbers and 16 commands, etc. An additional 16 or 32 words of high-speed storage would be helpful in allowing more data to be contained in the high-speed loops at one time.

INPUT

Manufacturer

Media	Speed
Paper Tape (Photoelectric)	400 char/sec
Control Console Keyboard	
Electric Typewriter	

Other methods are under development.

Melpar, Inc.

An off-line paper tape preparation unit should be used to avoid wasting computer time during keying operations. An off-line Flexowriter, with compatible code for this purpose, has been ordered.

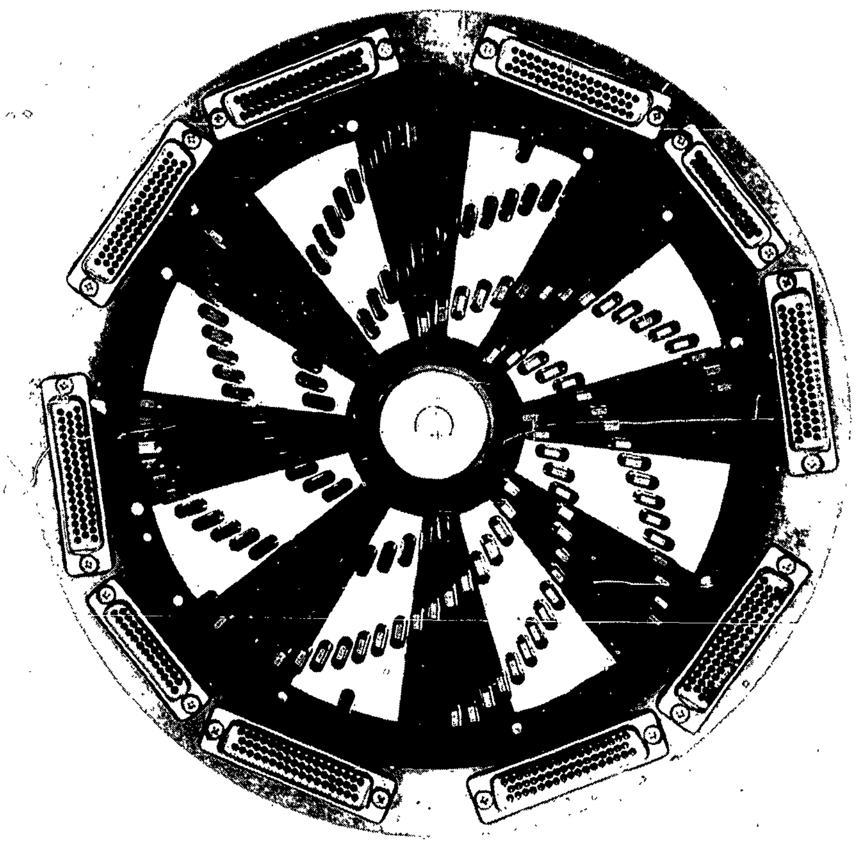


Photo by North American Aviation, Inc., Autonetics Division

OUTPUT

Manufacturer

Media	Speed
Paper Tape Punch	20 char/sec
Electric Typewriter	10 char/sec
Console Visual Readout (Nixie)	

Other methods are under development.

Machine operates in binary, but accepts decimal or alphanumeric input.

Melpar, Inc.

High-speed punch to be added in order to speed up output operations.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Approximate Quantity
Diodes	10,000
Transistors	2,000

CHECKING FEATURES

Manufacturer

All output is checked by echo signal to ensure accuracy.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	0.5 Kw
Volume, computer	4.7 cu ft
Area, computer	45 sq ft
Floor loading	80 lbs/sq ft
Weight, computer	197 lbs

115V, AC, outlet is required.

USA CDEC

Voltage regulation installed on 110V line.

USASS ADPS OD

Power, computer	0.4 Kw
Excluding typewriter and paper tape unit	
Room size	3 ft x 5 ft
Weight, computer, including Input-Output	400 lbs

No special site preparation is required. Power source may need a constant voltage regulator installed

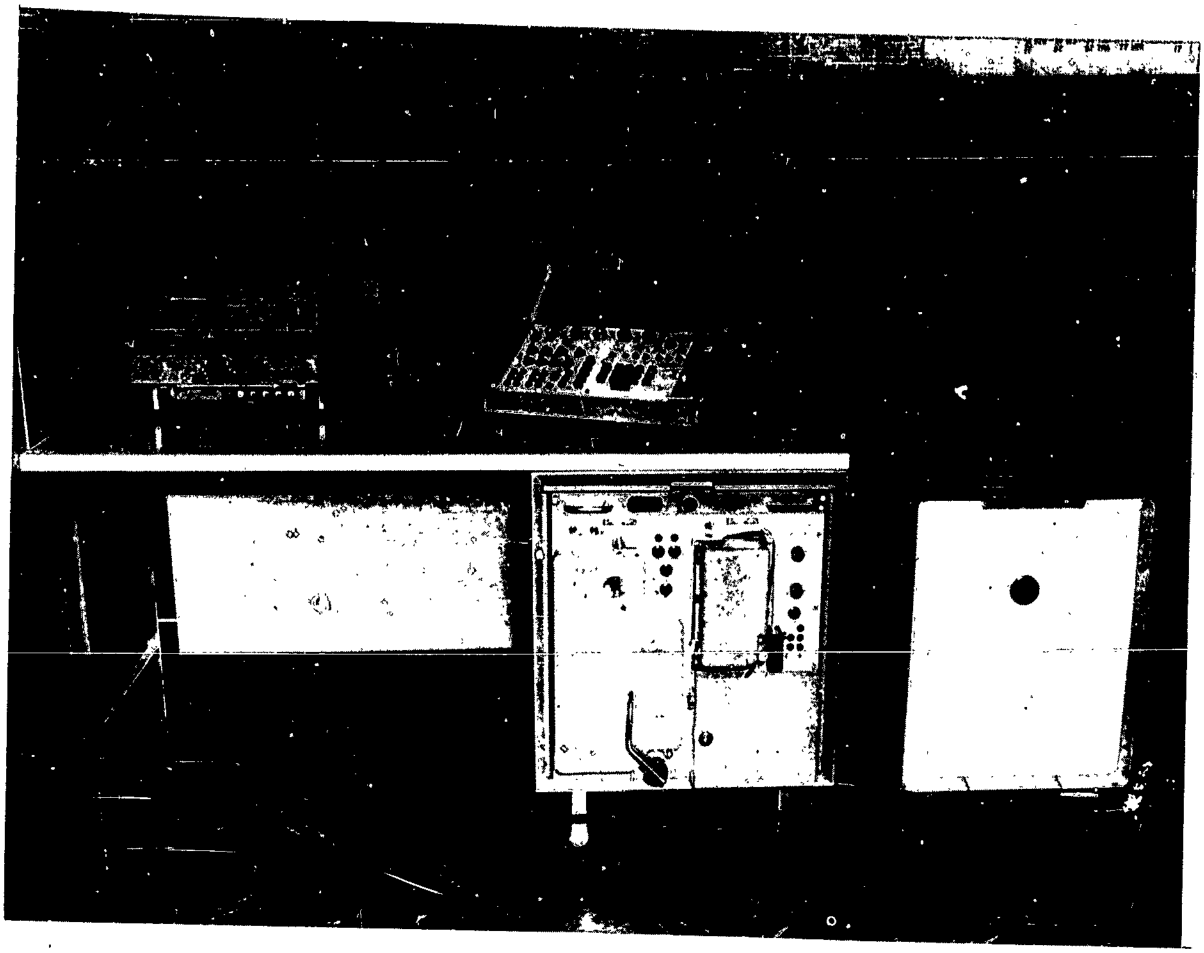


Photo by U.S. Army Combat Development and Experimental Center, Fort Ord

to minimize line transients effect on computer.

USASS Special Training Dept.

Room size	25 ft x 29 ft
Capacity, air conditioner	Approx 5 Tons

No special site preparation required.

Offutt AFB

Room size	10 ft x 10 ft including filing & maint equip

AC Voltage Regulator is the only necessary preparation.

Turner AFB

Power, computer 0.5 Kw	Approx 0.5 KVA > 0.95 pf
Room size	10 ft x 10 ft
Floor loading	45 lbs/sq ft 45 lbs concen max
Weight, computer	Approx 400 lbs

No site preparation is required. Machine operates on standard 115V outlet. Installation time is approx. 2 hours. Air conditioner is not required.

W - P AFB

Air conditioner is not necessary.
Desk size computer-loading etc., is negligible.
No site preparation is required.

Autometric Corporation

Room size	45 sq ft

No special site preparation or air conditioner is required. Power outlet is 115V, 60 cycle, single phase.

Melpar, Inc.

Room size	7 ft x 10 ft

Normal building air conditioner is used.

PRODUCTION RECORD

Manufacturer

Time required for delivery 3 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Price	Monthly Rental
Computer and memory, photo-electric tape reader, type-writer, tape punch, and console	$95,000	$3,000

Maintenance service included in rental. Purchaser service contract at $5,000 per year.

USA CDEC

Total cost of computing system $85,000.

2 Off-line Flexowriters cost $2,400 each. Total additional is $4,800.

Maintenance/service contract is $6,000 per year.

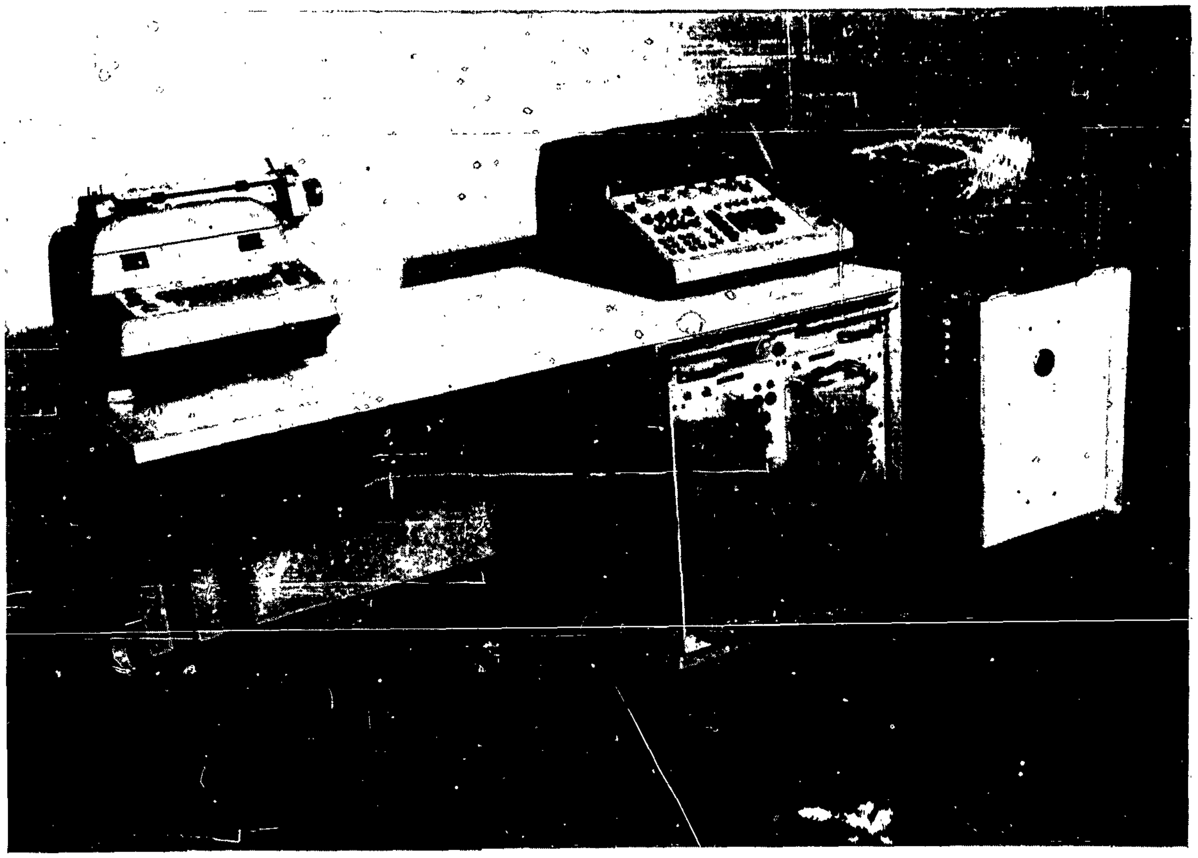


Photo by U.S. Army Signal School, Fort Monmouth

USASS ADPS OD
Rental is $3,000 per month, including maintenance service.

USASS Special Training Dept.
Annual maintenance contract with manufacturer is approximately $5,000.

Offutt AFB
Computer and input-output devices - $92,000. Two magnetic tape unit' price is undetermined. Maintenance service contract is approximately $20,000 per year plus parts.

Turner AFB
System cost is $92,000.

Autometric Corporation
Maintenance contract is at rate of $5,000 per year for one shift operation. Additional shifts are 50% of first shift.

Melpar, Inc.
Off-line Flexowriter and high speed punch cost $2,200.
Computer, typewriter, console, paper-tape reader and punch rent at $3,000/month including maintenance service.

PERSONNEL REQUIREMENTS

Manufacturer
One supervisor and one programmer per 8 hour shift. System can be used by persons desiring a solution to a problem even if they have little or no computer experience.
Complete operation training consisting of any or all of a 1 week familiarization course, a 2 week programming course, and/or a 1 week assembly and compiler course is made available by the manufacturer to the user. Maintenance course also available.

USA CDEC

	One 8-Hour Shift
Supervisors	1
Programmers	3
Clerks	1

Operation tends toward closed shop.
Methods of training used includes individual instruction.

USASS ADPS OD
A machine supervisor is recommended.
No formal operating procedures are necessary. Personnel familiar with the computer and programming may use the computer whenever they have the need on a first come basis.
Operation tends toward open shop.
Methods of training used includes manufacturer conducted on site courses lasting for periods of 1

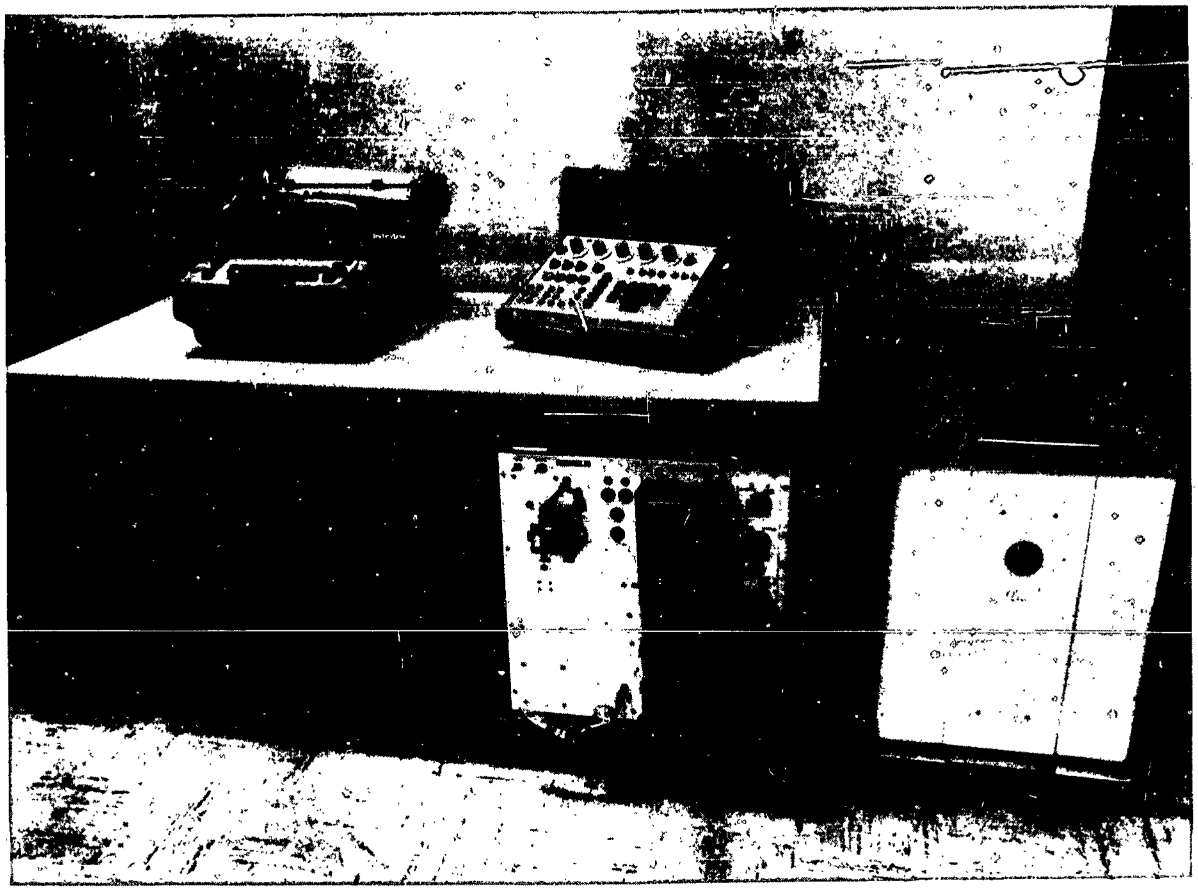


Photo by U.S. Air Force 544th Reconnaissance Group, Offutt AFB

week to 1 month.

USASS CONARC Briefing Team

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Technicians	1	1

Operation tends toward open shop.

Manufacturer conducted on site courses lasting for periods of 1 week to 1 month.

No formal operating procedures are necessary. Personnel familiar with the computer and programming may use the computer whenever they have the need on a first come basis.

USASS Special Training Dept.

Programming and operating are performed by instructor personnel to meet their specific training requirements.

Methods of training used includes training provided by manufacturer and on-the-job training.

Turner AFB

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Programmers		2
Operators	2	1

W - P AFB

Operation tends toward open shop.

A 40-hour course, spread over ten weeks, is given. Each student has, in addition, 20 or more hours of machine time, and he carries a problem of appreciable magnitude through all its stages.

Autometric Corporation

One programmer, who usually does own operating, is used and recommended.

Operation tends toward open shop.

Manufacturer of system offers a three week programming/operating course free with purchase of system. A programmer so trained may in turn instruct others at the home installation in the use of the equipment.

Offutt AFB

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Programmers	3	3
Technicians	1	1

Operation tends toward open shop.

Methods of training used include Computer Programmers School (2 weeks), frequent classes conducted by the Field Engineer, and on-the-job training.

Melpar, Inc.

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts	0	2
Programmers	3	4
Coders	0.5	2
Operators	0.5	1
In-Output Oper	0.5	1

Operation tends toward open shop.
Engineers were trained to use algebraic translator. (Some were trained to use machine code.)
Programmers (all familiar with at least one other computer) taught themselves from the manual.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USA CDEC

Good time 33 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.82
Above figures based on period 1 Jan 60 to 1 Jul 60
Passed Customer Acceptance Test 1 Oct 59
Time is not available for rent to outside organizations.

USASS ADPS OD

Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period 1 Jul 59 to 1 Jul 60
Time is not available for rent to outside organizations.
2 hours/week required for preventive maintenance.

USASS CONARC Briefing Team

Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period 1 Jul 59 to 1 Jul 60
Time is not available for rent to outside organizations.
2 hours/week required for preventive maintenance.

USASS Special Training Dept.

Average error-free running period 129.3 Hours
Good time 38 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period 28 Jun 60 to 10 Aug 60
Passed Customer Acceptance Test 28 Jun 60
Time is not available for rent to outside organizations

Turner AFB

Good time 30 Hours/Week (Average)
Attempted to run time 30 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 1.0
Above figures based on period 26 Jun 60 to 10 Aug 60
Passed Customer Acceptance Test 20 Jun 60
Time is not available for rent to outside organizations.

Autometric Corporation

Good time 29 Hours/Week (Average)
Attempted to run time 30 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period May 59 to Aug 60
Passed Customer Acceptance Test May 59
Time is not available for rent to outside organizations.

Melpar, Inc.

Average error-free running time 60-90 Hours
Good time 60 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 44 out of 45 starts
Above figures based on period 8 Mar 60 to 8 May 60
Time is available for rent to outside organizations.

There has been only one computer failure to date: two burned out diodes in the power supply.
There was difficulty with the typewriter and punch during the first month but they are both highly reliable now.
The RECOMP II system replaced a larger system, and is far more reliable, with only 2 hours maintenance per week instead of 10-15.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features - Rugged solid-state construction; simplified programming; built-in floating point arithmetic and square root; fingertip control console with digital readout; high-speed photoelectric tape reader (400 characters/sec); 49 commands; magnetic disk memory with 4,096 words, each of 40-bit length, including 16 words in high-speed loops.

USA CDEC

Outstanding features includes built in floating point commands, and Baudot (teletype) input.
Tape is stored in a fire proof safe file cabinet.
System is input-output limited.

USASS ADPS OD

Outstanding features include compact large family of instructions, easy to use and understand, and console. It is more rugged than most commercial computers and may be moved easily with only normal household goods type care.

USASS CONARC Briefing Team

Shipment between presentations done by commercial movers or in a specially constructed shelter which has modified shock mountings and built in recesses and tie-down straps for fast packing.

USASS Special Training Dept.

Unique system advantage is that the RECOMP paper tape code and FIELDATA 5 chan code are the same.
Transistorized, serial, binary, single address, internally stored program, general purpose, digital computer, with 49 instructions including 15 arithmetic instructions; 25 logical and transfer instructions; 9 input/output instructions. Among these are 9 built-in floating point instructions.

Offutt AFB

Outstanding features include two high speed rapid access loops, floating point arithmetic, completely transistorized, small computer compactness, and economy of power.

Turner AFB

Outstanding features include small physical size, no site preparation, reliability, and ease of programming.

W - P AFB

Outstanding features include ease of communication with the system and simplicity of coding.

Autometric Corporation

Outstanding features include Arabic numeric display under manual or program control and trapping mode (negative command actuated).Following built-in advantages include preset stop mode, checking features, verification mode for input, decimal to binary conversion on input, floating point, and three sense switches.
Unique system advantages include no special site preparation, no air conditioning, the system is portable, and ease of programming and debugging.

Melpar, Inc.
Outstanding features include reliability, automatic floating point, square root commands, and full word floating point exponent.

FUTURE PLANS

Manufacturer
Magnetic tape will be available in the near future, as soon as testing is completed.

USASS Special Training Dept.
As other equipment and components for this system become available and as they increase the effectiveness of the training offered, they will be added.

Offutt AFB
Two magnetic tape input-output units are to be installed in the near future. The computer will be sent back to Autonetics for modification. Anticipated time necessary for modification is between 30 and 90 days.

Turner AFB
Plan to add magnetic tape input-output system.

Melpar, Inc.
Modifications include off-line Flexowriter for input preparation and printing of results, a high-speed punch, a Melpar-built plotter using paper tape input, and a large-scale open shop training program. New applications expected are interference studies, satellite tracking, operations research and missile trajectories.

INSTALLATIONS

U.S. Army Combat Development Experimentation Center
Fort Ord, California

U.S. Army Signal School
ADPS, Officers' Department
Fort Monmouth, New Jersey

U.S. Army Signal School
CONARC Briefing Team
Fort Monmouth, New Jersey

U.S. Army Signal School
Special Training Department
Fort Monmouth, New Jersey

544th Reconnaissance Technical Group
Analysis Center
Offutt Air Force Base, Nebraska

1370th P. M. W.
Turner Air Force Base, Georgia

Institute of Technology (Air University)
Wright-Patterson Air Force Base, Ohio

Autometric Corporation
331 W. 44th Street
New York 36, N. Y.

Melpar, Inc.
11 Galen Street
Watertown, Massachusetts

REPAC

REPAC

MANUFACTURER

North American Aviation, Inc.
Autonetics Division

APPLICATIONS

System is designed for general purpose computing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	40 including sign bit
Binary digits/instruction	20 including sign bit
Instructions/word	2
Arithmetic system	Fixed and floating point
Instruction type	One address
Number range	$+1 \times 2^{39}$ Yo -1×2^{39}

Floating Point Exponent Range (+ or - 1×2^{39})
Instruction word format

Instruction	Sign Bit	Octal Digits Operation Code	Octal Digits Address	Half-Word Indicator Bit
First	(1/0)	(XX)	(XXXX)	(1/0)
Second	Same as first instruction			

Automatic built-in subroutines include automatic conversion from decimal to binary during input.

Registers include:
A - Accumulator register
R - Remainder register
B - Operand register
X - Exponent register
L - 8-word rapid access storage
V - 8-word rapid access storage

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	1,980	540
Mult	22,240	10,800
Div	22,740	10,800

Construction (Arithmetic unit only)

Transistors	1,500
Condenser-diodes	13,000
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Dec Digits/Word	Access Microsec
Disk Memory (Main)	4,080	12	8,000
Disk Memory (Rapid)	16	12	540

Magnetic Tape

No. of units that can be connected	32 Units
Channels or tracks on the tape	5 Tracks/tape
Transfer rate	30,000 Char/sec

Tape units have not yet been connected to the REPAC Computer at this time.

INPUT

Media	Speed
Paper Tape (Photoelectric)	400 char/sec 5 or 6 channel
Typewriter	Manual
Keyboard on Console	Manual

Input can be either command format, alphanumeric information, or decimal numbers from paper tape and typewriter and command or decimal from keyboard on console.

OUTPUT

Media	Speed
Paper Tape	20 char/sec 5 or 6 channel
Typewriter	10 char/sec
Nixie Tubes on Console	0.54 millisec/Nixie

Output can be either command format, alphanumeric information, or decimal numbers to paper tape and typewriter and command or decimal to Nixie tubes on console.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
HD2289	10,000
Other	2,000
Transistors	
All types	1,500

CHECKING FEATURES

Echo checking on punch and typewriter.
Verify mode on tape input.

POWER. SPACE. WEIGHT. AND SITE PREPARATION

Power, computer	0.6 Kw	5.4 KVA
Volume, computer		6 cu ft
Area, computer		4 sq ft
Room size, computer		One-man office
Floor loading		50 lbs/sq ft
Weight, computer		205 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

Not in production

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Programmers	1	1	2
Coders	1	2	3

Training made available by the manufacturer includes Service Engineer Training School and Programmer Training School.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include comprehensive control console with digital display, built in floating point, high-speed reader, and magnetic-disk memory.

This computer has been further developed into RECOMP II, which is produced in quantity.

INSTALLATIONS

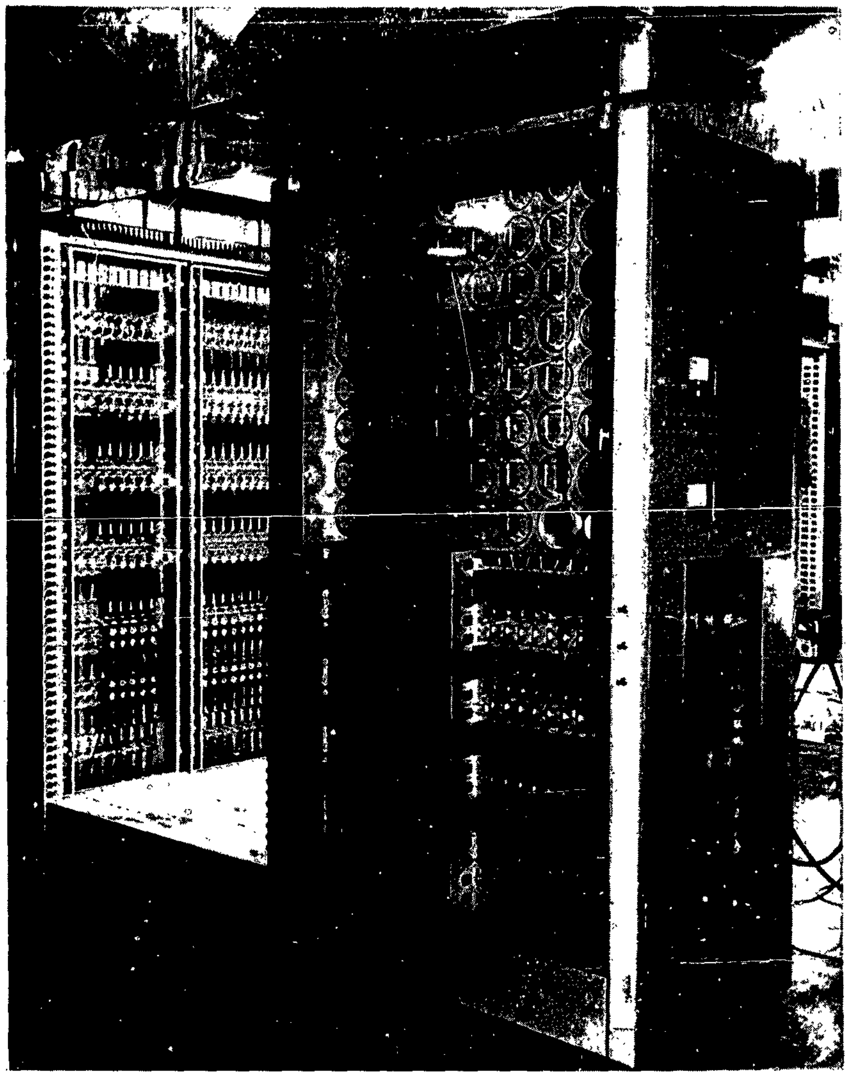
North American Aviation, Inc.
Autonetics Division
9150 East Imperial Highway
Downey, California

RICE UNIVERSITY

Rice University Computer

MANUFACTURER

Rice University



8,192 Word Electrostatic Memory

Photo by Bel Air - Rice University

APPLICATIONS

General purpose computing, primarily scientific applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number of binary digits per word	54
Number of instructions per word	1
Total number of instructions decoded	2^{13} Approx.

Arithmetic system	Fixed and floating point
Instruction type	One address

Two short addresses, initial fetch and final store or index arithmetic unit are possible.

Number range

Fixed point 0 to $1 - 2^{-47}$

Floating point $n = \pm c\ (2^8)^{\pm \epsilon}$

$0 \leqslant c \leqslant 1 - 2^{-47} \quad 0 \leqslant \epsilon \leqslant 31$

Instruction word format

6	15	6	12	15
Initial Fetch w/Inflections	Operation Code	Final Store	Index Modification, Inflections	Address

Automatic coding Assembly system, algebraic coding system being written, general compiling system being designed.

Registers and B-Boxes Arithmetic registers (54 bits): U,R,S, four temporary stores. Control registers (15 bits): Eight index registers, including control counter and pathfinder; Eight special purpose registers.

ARITHMETIC UNIT

Operation Microseconds	Incl. Stor. Access	Excl. Stor. Access
Add	50	40
Mult	85	75
Div	85	75

Operation times are for floating point.

Construction (Arithmetic Unit Only)
- 1000 Vacuum tubes
- 60 Transistors
- 5000 Diodes

Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

STORAGE

Media	Words	Digits	Access Microsec.
Electrostatic tubes	8,192	8,192x54	10
Fast Flip-flop Registers	4	4x54	1

Magnetic Tape

Maximum number of units that can be connected to the system	4 Units
Maximum number of characters per linear inch of tape	*430 Char/in.
Channels or tracks on the tape	10 Track/tape
Tape speed	75 In/sec
Transfer rate	*32,000 Char/sec.
Start time	6 Millisec.
Stop time	6 Millisec.
Average time for experienced operator to change reel of tape	*60 Seconds
Physical properties of tape	
Width	3/4 Inches
Length of reel	2,400 Feet

INPUT

Media	Speed
Paper Tape	300 char/sec
Magnetic Tape	4,000 words/sec

OUTPUT

Media	Speed
Paper Tape	60 char/sec
Printer	600 lines/min
	108 char/line
Magnetic Tape	4,000 words/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Type	Quantity
Tubes			
5965	3,000	1858	256
6147	300		
Diodes			
T3G	13,000		
Transistors			
2N585	500	2N393	1,000
2N598	400		

The above figures are for the final machine 32K-word memory. The 1858 tubes are used in the RADECHON fast storage unit.

CHECKING FEATURES

An error correcting code for 1 error/word operates with fast memory and magnetic tape.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	20 K.W.
Space, computer	400 sq. ft.
Space, air conditioner	5 ft. x 10 ft., blower
Capacity, air conditioner	13 tons

All equipment installed in an ordinary 50 ft. x 50 ft. room.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

The computer is being built with financial support by the Atomic Energy Commission at a cost of approximately $400,000.

PERSONNEL REQUIREMENTS

For One 8-hour shift during the construction phase:

Programmers	4
Engineers	3
Technicians	2
Secretary	1

INSTALLATIONS

Rice University
Houston 1, Texas

FUTURE PLANS

Memory capacity will be expanded to 32,768 words.

RPC 4000

Royal Precision Computer Model 4000

MANUFACTURER

Royal McBee Corporation
Librascope, Incorporated

Photo by Royal McBee Corporation

APPLICATIONS

Systems are located at Port Chester, New York and Burbank, California. Typical examples of applications include engineering, e.g. flight simulation, thermal distribution, motor fuel blending, heat exchanger design, highway design, water network calculations, electrical power loadflow calculations, optical ray trace, and reduction of wind tunnel test data; and business data processing, e.g. production control, payroll, accounts receivable, order analysis, financial statements, job costing, sales analysis, quality control, and operations research.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	32
Binary digits/instruction	32
Instructions per word	1
Instructions decoded	42
Arithmetic system	Fixed point
Floating point can be simulated	
Instruction type	Two address (one over one)
Number range	9 decimal digits
Instruction word format	

Sign	Command	Operand Address	Next Instruction Address	Index Tag
S	1 4	5 17	18 30	31

Automatic coding includes, compilers, assemblers, and interpretitive systems.

Registers include upper accumulator, lower accumulator, instruction, index, and 8008 memory registers.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	500	250
Mult	17,000	17,000
Div	17,000	17,000

Construction (Arithmetic unit only)
Transistors and diodes are employed as the circuitry of the 4000.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Next instruction designated

STORAGE

Medium	No. of Words	No. of Binary Digits	Average Access Microsec
Magnetic Drum	8,008	32	8,500

INPUT

Media	Speed
Paper Tape (Photo Electric Reader)	500 char/sec
Paper Tape (Tape Typewriter Reader)	60 char/sec
Punched Card Reader	
Magnetic Tape	

OUTPUT

Media	Speed
Paper Tape (High Speed Punch)	300 char/sec
Paper Tape (Tape Typewriter Punch)	30 char/sec
Tape Typewriter Print	12 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Transistors and diodes are used in the circuitry of the RPC-4000.

CHECKING FEATURES

Parity checks are included.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.725 Kw
Volume, computer	25.4 cu ft
Area, computer	8.8 sq ft
Room size	Depends upon equipment configuration
Floor loading	78.2 lbs/sq ft
	600 lbs concen max
Length, computer	46 3/4 in
Width, computer	27 in
Depth, computer	34 3/4 in
Weight, computer	600 lbs

Normal office power required.

COST, PRICE AND RENTAL RATES

Cost of basic system	
Computer (including one Tape Typewriter)	$87,500
Additional equipment	
Photo Electric Reader	15,000
High Speed Punch	20,000
Tape Typewriter (off line)	5,000
Rental for basic system	
Computer (including one Tape Typewriter)	$1,750
Rental additional equipment	
Photo Electric Reader	300
High Speed Punch	400
Tape Typewriter (off line)	150

Maintenance included in rental; service contract available for purchasers.

PERSONNEL REQUIREMENTS

Personnel requirements will vary according to the applications under consideration and the size of the system.

The basic system, i.e., computer and tape typewriter, tends towards an open shop type operation; however, since the system is modular and up to 17 input-output units (up to 60 with minor modifications) may be employed on-line at any time, the system as a data processing system would tend towards a closed shop type operation.

Training provided by the manufacturer includes programming schools for users at no extra cost, local assistance by applications analysts at no cost, and maintenance schools for users at a nominal additional cost.

ADDITIONAL FEATURES AND REMARKS

System is fully transistorized, large memory-8008 words, programming flexibility, high operating speeds, Index Register for automatic high speed address modification, repeat execution feature, complete memory search of 8,000 words in 2 1/2 to 4 seconds, high speed input and output, up to 17 input-output devices (or up to 60 with minor modifications), parity checking on input, dual access and high speed tracks, utilizes 110-120 volt "house current".

INSTALLATIONS

Royal McBee Corporation
Port Chester, New York

Royal McBee Corporation
Burbank, California

PRODUCTION RECORD

Number produced to date	10
Number in current operation	2
Number in current production	10
Number on order	75
Anticipated production rate	10 per month
Time required for delivery	4-6 months

RPC 9000

Royal Precision Computer Model 9000

MANUFACTURER

Royal McBee Corporation
Librascope, Incorporated

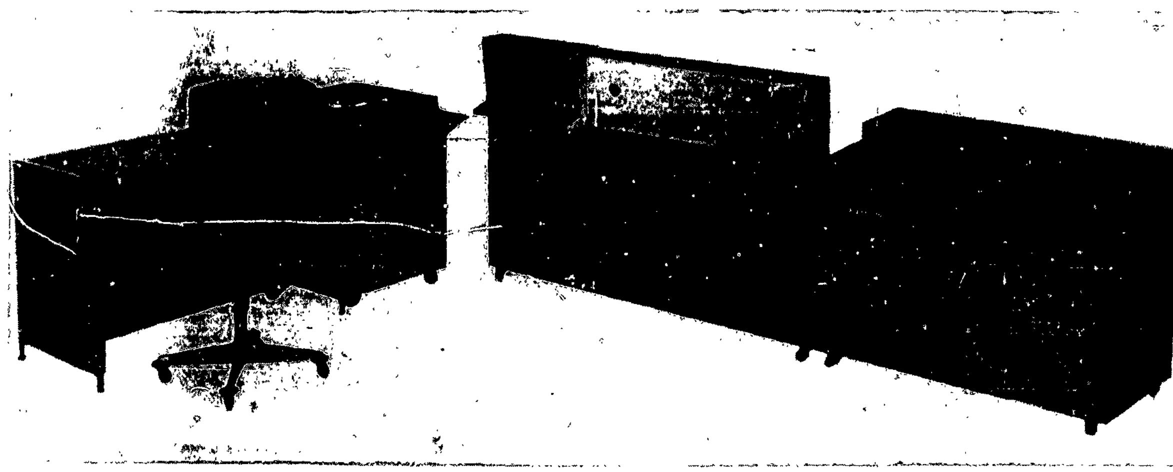


Photo by Royal McBee Corporation

APPLICATIONS

Located in Port Chester, New York and Burbank, California, system is designed for all typical business-type data processing and engineering type activities.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	12
Decimal digits/instruction	2
Instructions per word	6
Instructions decoded	43
Arithmetic system	Fixed point

Floating point can be simulated.

Instruction type	One address
Number range	12 decimal digits
Instruction word format	

Single Character Command, Single Character Address: e.g. the command may be F, the address may be P.

Automatic coding includes compilers, and assemblers.
Registers and B-boxes include 3 - Arithmetic Registers, 1 - Command Register, and 1 - Address Register.

ARITHMETIC UNIT

	Incl Stor Access Average Microsec	Exclud Stor Access Microsec
Add	110	230
Mult	2,860	1,980
Div	3,520	3,520

Access times are not optimized.
Construction (Arithmetic unit only)
Transistors and diodes are employed in the circuitry of the RPC-9000.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetostrictive Delay Lines	77	864	0.880
Magnetic Tape (per unit)	80,000	960,000	1,785,000

Magnetic tape access is average for a reel.

INPUT

Media	Speed
Paper Tape	500 char/sec
Cards	400 cards/min
Paper Tape (Punch and Reader)	60 char/sec
Tape Typewriter System	

OUTPUT

Media	Speed
High Speed Paper Tape Punch	300 char/sec
Punched Card Punch	100 cards/min
High Speed On-line Printer	667 or 1,000 lines/min
Paper Tape Punch and Reader	30 char/sec

In addition, there is a slower speed line printer at 150 lines per minute and the typewriter at 12 characters per second available as output.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Transistors and diodes are used in the circuitry of the RPC-9000.

CHECKING FEATURES

Parity checks are included.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.2 Kw
Volume, computer	43.4 cu ft
Area, computer	12.4 sq ft
Floor loading	24.2 lbs/sq ft
	300 lbs concen max
Weight, computer	300 lbs

Normal office power required.

PRODUCTION RECORD

Number produced to date	10
Number in current operation	4
Number in current production	25-30
Number on order	50
Anitcipated production rates	6 per month
Time required for delivery	9 months

COST, PRICE AND RENTAL RATES

Cost of basic system	
Computer	$60,000
Tape Typewriter System	5,000
Magnetic Tape Storage Unit	50,000
32 word-expandable Memory Units	5,000
Cost of additional equipment	
Photo Electric Reader	$15,000
High Speed Punch	20,000
Punch and Reader	2,500
Punched Card Reader	20,000
Punched Card Punch	25,000
Line Printer (150 lpm)	50,000
Line Printer (1,000 lpm)	175,000
Auxiliary Magnetic Tape Storage Unit	20,000
Rental for basic system	
Computer	$1,200
Tape Typewriter System	150
Magnetic Tape Storage Unit	1,000
32 word expandable Memory Unit	100
Rental additional equipment	
Photo Electric Reader	300
High Speed Punch	400
Punch and Reader	75
Punched Card Reader	400
Punched Card Punch	450
Line Printer (150 lpm)	1,000
Line Printer (1,000 lpm)	3,500
Auxiliary Magnetic Tape Unit	400

Maintenance included in rental; service contract available for purchasers.

PERSONNEL REQUIREMENTS

Personnel requirements will vary according to the applications under consideration and the size of the system.

Methods of training made available by the manufacturer are programming schools for users at no cost, maintenance schools for users at a nominal additional cost, and local assistance by applications analysts at no cost to user.

ADDITIONAL FEATURES AND REMARKS

Fully transistorized, random in-line processing, extremely high speed processing, compatible with any alphabetic or numeric "account number" system, complete file search - every record inspected on every cycle, data parity checked, all data in decimal form, internally stored program, tape cartridges easily interchanged, up to 30 input-output devices operating simultaneously, overlapped functions, modular construction throughout, efficient program storage-2 characters per instruction, fully automatic operation.

INSTALLATIONS

Royal McBee Corporation
Port Chester, New York

Royal McBee Corporation
Burbank, California

RW 300

Thompson Ramo Wooldridge Computers Company
Model RW 300

MANUFACTURER

Thompson Ramo Wooldridge Computers Company

Photo by Thompson Ramo Wooldridge Computers Company

APPLICATIONS

Manufacturer

Automatic, on-line, real-time uses include industrial process control, process data logging, pilot plant operation, quality control testing, electronic or electromechanical systems checkout, test stand data acquisition and data reduction. Off-line uses include general purpose computing.

System has built-in analog-digital conversion logic. Programming is not required to store analog data in memory. System has built-in digital-analog conversion logic. Program is required only to change the output values.

National Aviation Facilities Experimental Station

Located at the NAFEC, Federal Aviation Agency, Atlantic City, New Jersey, the system is used for air traffic control simulation, and terminal area sequencing control for the Idlewild area. Twenty simulators via analog tieup are connected to the 300 for input and digital displays are connected for output. With these, a simulation of aircraft in the terminal area and the IFR Room are produced for testing man-machine automization of air traffic control.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary
Binary digits/word	17 bits plus 1 sign bit
Binary digits/instruction	36 (2 words)
Instructions per word	one-half
Instructions decoded	21
Arithmetic system	Fixed point
Instruction type	Two address (one plus one)

National Aviation Facilities Experimental Station (FAA)

Photo by Thompson Ramo Wooldridge Computers Company

Number range $\pm (2^{18} - 1)$

Instruction word format

WORD ONE		2 WORDS WORD TWO	
18 14	13 1	18 14	13 1
Execution Code	Operand Address	Operation	Next Instruction Address

Automatic built-in subroutines include a program loader.

Automatic coding features include "OPUS", a routine for compiling optimum-coded computer program from sequential, symbolic listing, and "SAFARI", an assembly and interpretive program for scientific problems.

Registers include an A register (accumulator), a B register (lower accumulator), 3 one-word control registers, and an output-buffer register (18 bits).

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	780	780
Mult	2,990	2,990
Div	3,120	3,120

Construction (Arithmetic unit only)
  Transistors approx. 580
  Diodes approx. 4,000
Arithmetic mode Serial
Timing Synchronous
Operation Sequential
  Zero access for optimum coding
  8,330 microsec avg. access for sequential coding

STORAGE

Manufacturer

Media	No. of Words	No. of Binary Digits	Access Microsec
Magnetic Drum	7,936 or 15,520	18 x 7,936 or 18 x 15,520	8,330 avg.

Magnetic drum contains 32 words of fast-access memory; 2,080 microsec avg.

The 8,330 microsec average access is for general storage only.

Magnetic Tape

No. of units that can be connected	8	Units
No. of chars/linear inch of tape	240	Char/inch
Channels or tracks on the tape	8	Tracks/tape
Blank tape separating each record	0.5	Inches
Tape speed	75	Inches/sec
Transfer rate	2,560	Words/sec
Start time	less than 5	Millisec
Stop time	less than 5	Millisec
Physical properties of tape		
Width	0.5	Inches
Length of reel	2,400	Feet

The magnetic tape system is available in 150 and 240 lines per inch models; the figures above are for the 240 lines/in model.

The tape system can be purchased compatible with both RW 300 and IBM 709 equipment.

National Aviation Facilities Experimental Station

Media	No. of Words	Access Microsec Average
Drum	7,936	830
Core Buffer	128	215/128 words

INPUT

Manufacturer

Media	Speed
Paper Tape	10 char/sec
	60 char/sec optional
Digital On-off Signals	Up to 540 bits available
Analog	Continuous. Up to 1,920 samples/sec and 1,024 channels of input

National Aviation Facilities Experimental Station

Keyboard (Flexowriter)	9 char/sec
Paper Tape (Ferranti)	60 char/sec
Magnetic Tape	1,920 words/sec
Analog	128 10 bit words
Digital	700 microsec

Paper tape is 8 level. Analog output is updated every 2.1 seconds. The digital output is up to 18 bits at a time.

OUTPUT

Manufacturer

Media	Speed
Automatic Typewriter	10 char/sec

Several typewriters can be operated simultaneously.

Paper Tape Punch	10 char/sec

60 char/sec punch optional

Analog	Continuous up to 128
Digital On-off Signals	Up to 540 bits available

The RW 300 is unique in that the input-output, buffering, selection, and analog-digital conversion equipment are an integral part of the computer and operate completely independently of the program. The RW 300 can therefore be connected directly to measuring instruments and control devices.

National Aviation Facilities Experimental Station

Media	Speed
Typed Page (Flexowriter)	9 char/sec
Paper Tape (Flexowriter)	9 char/sec
Paper Tape (Teletype)	60 char/sec
Magnetic Tape	1,920 words/sec
Digital	700 microsec

Paper tape is 8 level. Digital output is up to 18 bits at a time.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity
Tubes	13
Diodes	4,000
Transistors	580
Magnetic Cores	2,304

The tubes are used only in the power supply. The magnetic cores are used in the tape-to-computer buffer storage. The diode and transistor quantities are approximate.

CHECKING FEATURES

Manufacturer

There is an optional parity bit on the Flexowriter input/output.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	0.5 Kw	120 Volts	60 cps
Volume, computer		33.5 cu ft	
Area, computer		11.2 sq	
Room size		Small	
Weight, computer		600 lb.	

Volume figure does not include input-output equipment.

National Aviation Facilities Experimental Station

Power, computer	1 Kw
Volume, computer	72 cu ft
Area, computer	18 sq ft
Room size	8 ft x 10 ft
Floor loading	40 lbs/sq ft
	90 lbs concen max
Weight, computer	700 lbs

Room is kept below 86°F by building air conditioning.

False floors for cable runs is installed.

Humidity and temperature is controlled at 72°F and 50% relative humidity.

PRODUCTION RECORD

Manufacturer

Number in current operation	18
Anticipated production rates	4 per month
Time required for delivery	6 months

COST, PRICE AND RENTAL RATES

Manufacturer

Price of basic computer (includes automatic typewriter and paper tape punch) is $98,000.

Price of input-output system (Analog), optional equipment, control console, and magnetic tape units, is available on request.

On-call maintenance contract and full-time maintenance contract are available.

National Aviation Facilities Experimental Station

The price of the basic computer, a Ferranti High Speed Punch, an input-output distribution panel, a real time clock, one analog to digital-digital to analog converter and 4 magnetic tape units cost $212,920.

Two data flow systems, 64 analog input channels, 36 analog output channels, 504 digital outputs, and 288 digital inputs cost an additional $90,673.

Rentals for these are $5,962 and $2,589 per month, respectively.

Maintenance/service contract is $3,000/month.

PERSONNEL REQUIREMENTS

Manufacturer

After installation, the system is designed to operate 24 hrs/day, 365 days/year, with no direct supervision. For 3 - 8 hour shifts, 3 operators and 1 technician are needed.

Training made available by the manufacturer to the user includes Programming course (2 weeks to 4 weeks), a Theory of Operation course (3 weeks), and a Maintenance course (4 weeks). Operators are trained on site. All but maintenance course are free of charge at Beverly Hills facility.

National Aviation Facilities Experimental Station

	One 8-Hour Shift
Programmers	6
Coders	2
Clerks	1
Librarians	1

Operation tends toward open shop.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

The system is designed and built for continuous (24 hrs/day, 365 days/yr) operation under normal environmental conditions in process plant control rooms. It is completely transistorized except for the power supply. Less than 1% unscheduled down time experience in the majority of installations. These remarks are based on approximately 48 operating months in actual control installations.

National Aviation Facilities Experimental Station

Average error-free running period 40 Hours
Good time 40.0 Hours/Week (Average)
Attempted to run time 40.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period Nov 59 to Apr 60
Passed Customer Acceptance Test Nov 59
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include integration of analog/digital conversion equipment in one package, high reliability, and compact size.

Unique system advantages are that one system can measure process conditions, compute proper settings for optimum process operation, and automatically control process variables.

A typical RW 300 reactor monitoring system includes an RW 300 Digital Control Computer as the central unit; the required analog and digital input-output equipment; standard measuring and sensing instruments such as compensated and uncompensated ion chambers and scintillometers, and pressure, temperature, and flow sensors; indicating devices; and, where desirable, control devices actuated by the computer.

In operation, the RW 300 continuously scans the instruments connected to it, converts analog and other readings to binary digital form, calculates corrections for measured values where necessary, compares these values against predetermined limits, actuates alarm and warning devices when limits are exceeded, and prints out measured and calculated data.

To insure that the protection of continuous monitoring is available without interruption, two RW 300 computers can operate in parallel (as is the case in two nuclear power station installations in France), with both machines receiving all input data and making all calculations. Only one of the computers operates the automatic typewriters, the alarm devices, and the other output devices. If that computer stops or makes a mistake, the other computer automatically takes over the output device communications.

Alternatively, the first computer might have the single function of alarm scanning, with the second computer and the tape unit used for computations, statistical correlations and trend analyses, data logging, processing of historical data read into the computer from the tape, and control of reactor and power plant variables, as well as backing up the alarm scanning computer.

National Aviation Facilities Experimental Station

The RW 300 is unique in that the input-output, buffering, selection, and analog to digital conversion equipment has been made an intergal part of the computer.

Magnetic tapes are stored in metal cabinets in the computer room with temperature and humidity controls.

INSTALLATIONS

National Aviation Facilities Experimental Station
Federal Aviation Agency
Atlantic City, New Jersey

RW 400

Polymorphic Data Processing Systems Model RW 400

MANUFACTURER

Ramo Wooldridge Division
Thompson Ramo Wooldridge Division

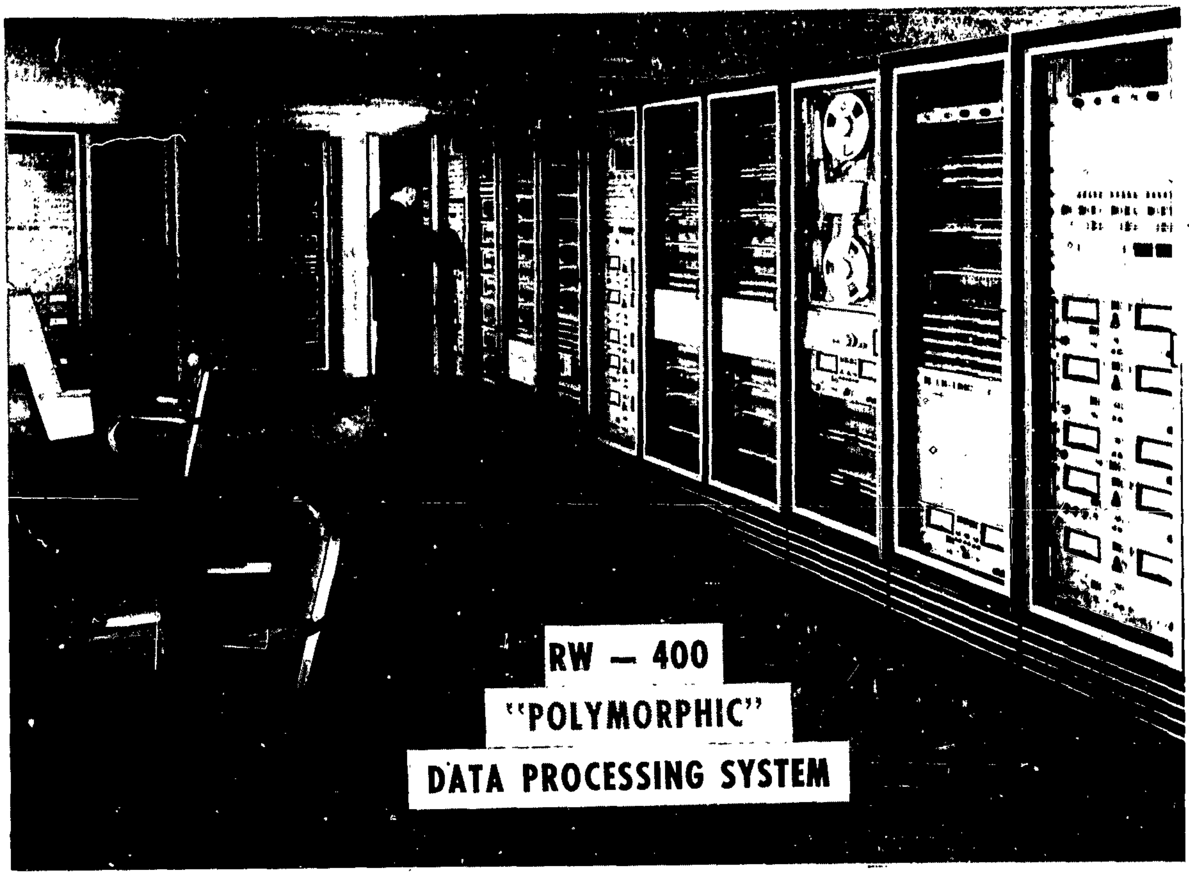


Photo by Ramo Wooldridge Division, Thompson Ramo Wooldridge, Inc.

APPLICATIONS

General or special purpose data processing and real-time, on-line, instrumentation, data processing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	26 + 2 parity
Binary digits/instruction	26
Instructions per word	1
Instructions decoded	38
Arithmetic system	Fixed point
Instruction type	Two address

System has some 3-address capability, due to special instructions.

Instruction word format

26 21	20 11	10 1
Op Code	First Operand Address	Second Operand & Result Address

Registers include an exchange register, an instruction register, a program counter, accumulator (A), accumulator extension (B), and a sense register.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	36 (555555+555555)
Mult	80 (555555x5555)
Div	128 (3086108025/5555)

Arithmetic unit is constructed of transistors.

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Media	No. of Words	Access Microsec
Magnetic Core	Variable; 7 char/word	10
Magnetic Drum Modules	8,192 each; 7 char/word	8,500

A variable number of drums and core units may be added. The characters are numeric.

Magnetic Tape Modules

No. of units that can be connected	64 Units
No. of alpha chars/linear inch	400 Chars/inch
No. of numeric chars/linear inch	700 Chars/inch
Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	1.25 Inches
Tape speed	150 Inches/sec
Transfer rate	105,000 Chars/sec
Start time	1.5 Millisec
Stop time	1.5 Millisec
Average time for experienced operator to change reel	30 Seconds
Physical properties of tape	
Width	1 Inch
Length of reel	2,400 Feet
Composition	Mylar

INPUT

Media	Speed
Peripheral Buffer (Drum)	8,192 words 3,600 rpm - 8.5 ms av. access

Up to 32 input/output devices may be connected to a peripheral buffer incl. flexowriters, consoles, card readers, etc.

Central Exchange 35 microsec connect speed

For direct connect of input devices to system, card read, tape read, flexo, etc.

Cards 2,000 cards/min

Variable read format is utilized.

OUTPUT

Media	Speed
Typed Page (Flexowriter)	10 char/sec
Paper Tape (Flexowriter)	10 char/sec
Printer (Analex)	900 lines/min
Plotter	lines ≈ 25 increments/min symbols ≈ 50/min

Card Punch --etc.

The Flexowriter is modified for edge-punched cards and 7 level paper tape, read and punch. 32 may be connected to one peripheral buffer.

Additional input/output devices include a display and analysis console and a data communication console.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Size, weight and power requirements for some typical RW 400 modules. A false floor for cabling is recommended.

Item	Dimensions (feet) L.	W.	H.	Weight (lbs)	Power (KW) Requirements	Mechanical Blower Capacity cu ft/min	Heat Dissipation BTU/min
Computer Module	8	2	7	1,800	2.665	1,866	152
Buffer Module	6	2	7	1,450	2.545	1,474	145
Tape Module	2	2	7	1,000	1.460	392	83
Tape Adapter	2	2	7	1,000	1.200	392	68
Central Exchange (large)	8	2	7	2,000	4.445	1,866	255
Central Exchange (small)	6	2	7	1,450	2.755	1,474	160
Drum Module	2	2	7	1,000	0.460	392	26
Printer, Elec. (large)	8	2	7	1,900	9.635	1,866	550
Printer, Mich.	2.5	3.5	2	300			
Peripheral Buffer	8	2	7	1,800	3.925	1,866	225
Display Buffer	4	2	7	1,100	0.540	784	31
Flexowriter	Small			100	0.250	- -	15
Plotter	6	4	3	1,500	1.000	- -	57

PRODUCTION RECORD

Number produced to date	4
Number in current operation	3
Number in current production	2
Number on order	4
Time required for delivery	9 months

COST, PRICE AND RENTAL RATES

Price on a per module basis is available on request.

Maintenance/service contracting is available.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The RW 400 was designed as the AN/FSQ 27 and meets the required Military Specifications in construction and reliability.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a multiple input-output capability, full parallel processing capability, limited only by size of the particular installation and a distributed memory and control.

Unique system advantages include expandability and flexibility. System can be a small tailored installation and then be expanded by addition of related modules to meet new or more stringent requirements. Expansion does not necessitate re-programming.

Programming Convenience. The natural format of the two-address instruction logic, augmented by three arithmetic modes (replace, hold and store), makes powerful concise programming easy. The 38 basic instructions are readily learned, and easily applied. They are sufficiently generalized and varied to permit expansion in accordance with the programming situations. A programmer is thus able to employ the full power of the computer to every problem rather than that defined by his own subset of an overly long and randomly evolved instruction list. The direct access of computer instructions, via the indirect addressing and address incrementing feature, to data in a connected buffer's storage minimizes data transferral housekeeping. The buffer's self-instruction ability maximizes computer utility by providing parallel data acquisition while computing is taking place. Programmed control over the computer's response to externally initiated "alert" signals permits nondisruptive handling of system interrupt requests. The generalized input-output instructions make man-machine communication devices operable as integral parts of the RW 400 system.

For this type of programming the computation system provides a mnemonic compiler system, necessary input-output routines, basic scientific subroutines, and diagnostic routines such as selective output, trace, and dump.

Types of service routines include:

"Dump" routines enable the programmer to obtain printed listings of the contents of computer and buffer core storage.

Drum and magnetic tape dumps.

Magnetic tape editing routine.

Program analyzer routine.

Tracing routine.

Types of scientific subroutines include:

Fixed point elementary functions - trigonometric, logarithmic, and exponential.

Fixed point numerical integration.

Binary to binary coded decimal conversion.

Interpretive multiprecision floating point abstraction.

Many other routines are being written to provide a complete service package.

The RW 400 is a unique data processing system which permits many new programming techniques. For example, many computations divide naturally into independent but related parts. These independent parts may be programmed for separate computers within the RW 400 system. The separate computations may proceed simultaneously with resultant low execution time. New programming techniques are developing methods of employing more than one computer for economical high-speed solution of problems which do not separate naturally into independent parts.

RW 400 Module Descriptions

Central Exchange CX-400 and Interim Exchange IX-400

The IX-400 or CX 400 provides all of the communication paths between modules of the system. Its size is dependent upon the number of required paths. The interim exchange, a transistor-diode device, is adequate for small systems; for large systems the central exchange, a transfluxor device, is available. Features of the exchanges are as follows:

The exchange function at electronic speeds.

The exchange is controlled by both computer and buffer modules.

All transmission formats are standard.

Unidirectional transmission is employed.

Each exchange itself can be increased in capacity by adding more channels.

The RW 400 central or interim exchange performs a function similar to a telephone exchange. On request, it will set up a communication path between modules of the system. Several communication paths between different pairs of modules can exist at any given time; however, a request for connection to a module in use will result in a "busy" signal. It is convenient to think of the central exchange as a rectangular array of crosspoints, having computers and buffers positioned along one axis, and devices to which they can connect along the other axis. Only CM 400's and BM 400's can request connections; hence these are the executive elements. RW 400 modules communicate in a standard format, and can be connected into the central exchange in an arbitrary poisiton; however, since buffers and computers must communicate, each buffer has a position on both axes of the crosspoint array.

In its implementation the central exchange bears little resemblance to the telephone exchange. A conversation path actually consists of 37 lines in parallel, and the information rate through the exchange can be as high as 400,000 bits per second per line. Connections are made at electronic speeds.

Computer Module, CM 400

The CM 400 is a high-speed, general-purpose digital computer which is housed in a four-bay cabinet approximately 7 feet high, 8 feet wide, and 2 feet deep. The characteristics and capabilities of the CM 400 are described in the following paragraphs:

High-Speed Operations: There are 38 internal instructions for arithmetic and logical operations. The CM 400 is a parallel binary computer. The computer instruction word is 26 bits long and has two 10-bit addresses and a 6-bit operation code. A typical instruction line, including both memory accesses, is 40 microseconds, an add operation is performed in 35 microseconds, and a multiply operation is performed in 80 microseconds. Five general external (input-output) instructions are provided.

The computer instructions have two addresses. The set of arithmetic instructions has been chosen in a manner to effectively provide three-address efficiency in many cases. Each of the arithmetic operations-addition, subtraction, multiplication, division, square root of a sum, occur in three modes: replace, hold and store. In the replace mode, a division operation, for example, calls out two operands - the divisor and dividend - from the addresses specified by the instruction. After completion of the operation, the quotient is stored in one of the operand locations. In the hold mode, the same process occurs except the quotient is held in the accumulator and is not stored in memory. In the store mode of division, the divisor is obtained from any address in memory but the dividend is taken as the number retained in the accumulator at the end of the preceding instruction. The quotient is then stored in the location specified by the second address of the instruction. These three modes provide practically all of the one and two address combinations desired for arithmetic operations. Special interpretation is made of addresses containing all zeros or all ones - the latter providing access to operands or result locations in the memory of a connected buffer module.

Memory. The CM 400 has a 1,024-word random access magnetic core memory. The read-write cycle time is 10 microseconds. Stored words are 28 bits long - 26 bits of information and 2 parity bits.

Interrupt Capability. Automatic interrupt of a CM 400 is controlled by the masking action of an internal sense register which is under program control. Interrupts may be due to "master" computer intervention, alerting signals from external system modules, and internal conditions such as overflow. An interrupted CM 400 may be programmed to process the condition that caused the interrupt. It then returns to its normal sequence of operations at the point of interruption.

In more detail, each computer has a 20-bit sense register which permits program-controlled interruptions. Each flip-flop of this register senses an alert signal. If an alert signal becomes true and the sensing flip-flop is also true, then a program interrupt occurs. Interruption causes the computer program to next take the instruction stored in address zero. This instruction causes the program to jump to an "interrupt" subroutine. Conventional instructions are used to save the contents of the arithmetic registers and the address at which to reenter the interrupted program. Thirteen of the twenty alert conditions can be arbitrarily assigned from external sources. The remaining conditions arise from internal sources such as overflow, "ready" or other status signals received during standard communication.

Switching Capability. A CM 400 may connect itself through the central exchange to any available buffer module, tape module, tape adapter, drum module, printer module, peripheral buffer, or display buffer. Connections are made within the central exchange. All modules communicate over identical standard cables.

The system network of alert signals of the RW 400 is required in multiple computer systems to permit one computer to control the operation of other computers. It allows the system to efficiently accept infrequently occurring asynchronous input signals, and can be used to implement the timing of certain kinds of computer operation. Alert signals are extremely useful for indication of operator requests, causing prompt response to queries or modifications of console displays. If two or more occur simultaneously, the resulting interrupts are processed in a specifiable order or priority.

FUTURE PLANS

Plans include a new 32,000 word memory, word length up to 48 bits, optional, and automatic floating point.

SCRIBE

Scoring and Data Transcription Computer

MANUFACTURER

United Aircraft Corporation
Norden Division

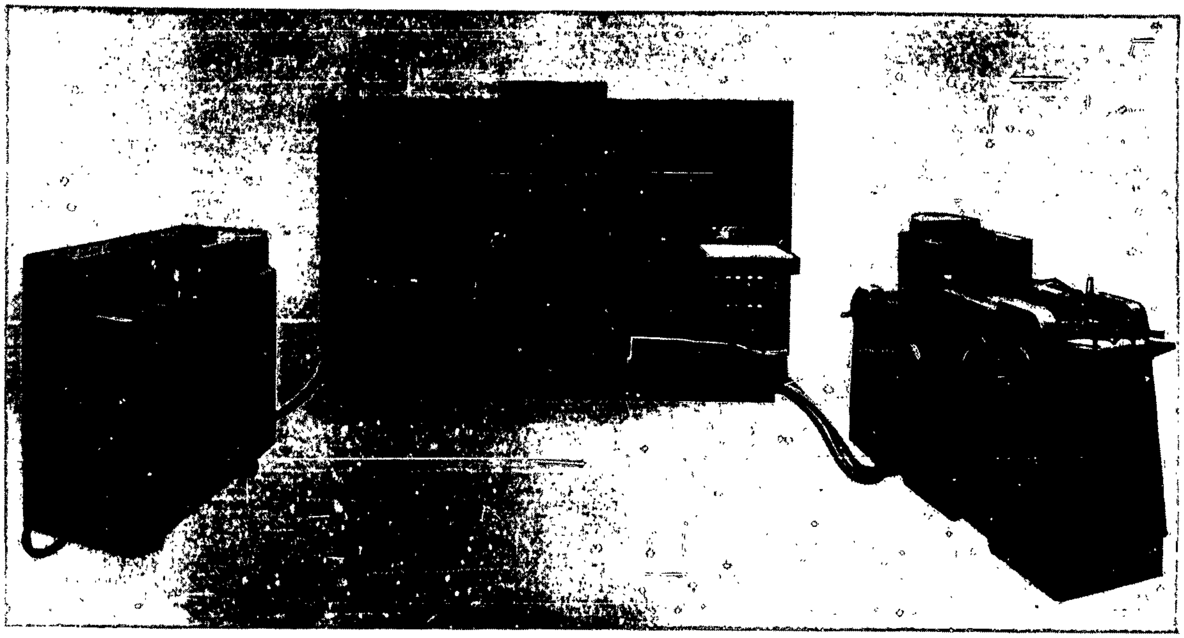


Photo by Educational Testing Service

APPLICATIONS

Manufacturer

System is used for special purpose data processing and off-line scoring and transcription, with general applications to topologically equivalent systems.

Educational Testing Service

Located at Princeton, New Jersey, the SCRIBE consists of a paper handler and mark-sensing unit, a processing unit and a card punch. It is designed primarily for the processing of test answer sheets. As a data processor and transcriber, it processes up to 2,240 pencil marks on one side of one 8 1/2" x 11" sheet of paper onto one punched card at the rate of 100 sheets per minute.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary Coded Decimal
Decimal digits/word	Variable
Binary digits/instruction	5
Instructions per word	Variable 1 to 3
Instructions decoded	15

A single bit adder is used.

Instruction type	One address
Number range	0 - 999

Instruction word format is variable.

A wired program interpreting core memory is used. The equipment is a special purpose data processor used mainly for the scoring and transcription of answer sheets. It can be used for other topologically equivalent documents. It is programmed by scanning an array sheet which is marked in accordance with the identification instructions and their addresses. A drum memory with 24 answer keys is used for automatically scoring as many as 6 different keys indicated on an answer sheet.

ARITHMETIC UNIT

Manufacturer

Construction (Arithmatic unit only)

Transistors and diodes are used in a single bit adder.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	No. of Bits	Access Microsec
Core	600	17	14
Drum	784	40	17,000

The drum memory also contains two 480-bit recirculating registers for output buffering to card punch.

INPUT

Manufacturer

Medium	Speed
8 1/2 x 11 inch Sheet (2240 marking positions)	100 sheets/min

The sheet is arranged into 40 positions per row and a maximum of 56 rows. The row arrangement is 8 groups of positions.

OUTPUT

Manufacturer

Medium	Speed
Punched Card (80 column)	100 cards/min

Parallel card punch speed synchronous with input.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity
Diodes	
1N770	Approximately 5,000
et al	
Transistors	
2N317	
2N388	
2N404	
2N426	
and others	
Total	Approximately 3,500
Magnetic Cores	10,800

There are a few vacuum tubes (110) in the system for voltage reference plus the photomultiplier tubes used for sensing.

CHECKING FEATURES

Manufacturer

Checking features include many built in routines plus parity check on magnetic core memory.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

KVA, System	3 KVA
Volume, System	250 cu ft
Area, System	50 sq ft
Floor loading	86 lbs/sq ft
Weight, System	4,300 lbs

Air conditioned at 60° - 95°F
Relative humidity at 20% - 60%.
208 V, 3 phase, 60 cps

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts
Operators	1	2
Engineers	1	1
Technicians	1	2
In-Output Oper	1	2

Training made available by the manufacturer to the user includes training to suit users requirements.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Provides mark sensing capabilities of most intense mark in a group plus ability to provide for variations in background level. Includes printing facility for identifying sheets in alternate stack. System has a capability of scoring mixed answer sheets of different tests.

Educational Testing Service

Outstanding features include sensing of marks by reflected light, extensive automatic checking, and stored-program processing.

Unique system advantages include the ability to use any of 24 distinct scoring keys during one scoring run, the ability to process positionally coded information, and the ability to shunt certain sheets aside for separate processing.

INSTALLATIONS

Educational Testing Service
20 Nassau Street
Princeton, New Jersey

SEAC

Standards Electronic Automatic Computer
General Purpose Scientific Calculator

MANUFACTURER

National Bureau of Standards
U. S. Department of Commerce

Picture by National Bureau of Standards

APPLICATIONS

General data processing, scientific calculation and engineering development. Man-machine systems studies in conjunction with analog computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	44 plus sign
Binary digits per instruction	45
Instructions per word	1
Instructions decoded	16
Instructions used	16 + 2 optional (switch)
Arithmetic system	Fixed point
Instruction type	Three or four address (switch)
Number range	$-(4 - 2^{-42})$ to $+(4 - 2^{-42})$

Instruction word format

4 Address	10 bits α	10 bits β	10 bits γ	10 bits δ	4 bits operation	1 bit sign

3 Address	12 bits α	12 bits β	12 bits γ	4 bits counters	4 bits operation	1 bit sign

In 3 address operation instruction sequencing is done by 2 counters which are independently sequenced by bits in the instruction. Relative programming can thus be accomplished.

Picture by National Bureau of Standards

ARITHMETIC UNIT

	Incl. Stor. Access Microsec.	Exclud. Stor. Access Microsec.
Add time	192 - 1,540	48
Mult time	2,300 - 3,650	2,112
Div time	2,300 - 3,650	2,112

Construction 1200 Germanium diodes, 80 delay lines, 60 pulse transformers, 61 vacuum tubes.

Rapid access word registers	3
Basic pulse repetition rate	1 Megacycle/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

Operation time varies with memory being used. Acoustic and electrostatic memory may be used together in computer.

STORAGE

Media	Words	Digits	Microsec Access
Acoustic (Mercury)	1,024	46,080	216 (avg)
Electrostatic (CRT)	1,024	46,080	12
Magnetic Tape	24,000	$52 \times 24 \times 10^3$ bits/unit	

No. of units that can be connected	5 Units
No. of chars per linear inch	260 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	37.5 Inches/sec
Transfer rate	104 Chars/sec
Start time	0.5 Millisec
Stop time	0.5 Millisec

Physical properties of tape

Width	.5 Inches
Length of reel	3600 Feet
Composition	Mylar - 1 Mil

Multi-channel tape system is under construction.

INPUT

Media	Speed
Keyboard (Flexowriter)	Manual (Max 10 char/sec)
Paper Tape (Flexowriter)	10 char/sec
Paper Tape (Potter)	150/600 char/sec(Photoelectric)
Magnetic Wire (Pierce)	65 words/sec (New unit)
Magnetic Tape	135 words/sec (Single Channel)
Magnetic Tape	4,500 words/sec (Multichannel)
Punched Card	330 char/sec

OUTPUT

Media	Speed
Printer (Flexowriter)	10 char/sec
Paper Tape (Flexowriter)	10 char/sec
Paper Tape (Teletype)	58 char/sec
Paper Tape (Soroban)	240 char/sec
Magnetic Wire (Pierce)	65 words/sec
Magnetic Tape	135 words/sec
Magnetic Tape	4,500 words/sec

Input-output word lengths are single word, 8 words, or variable block up to capacity of memory with single instruction.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
6AN5	1,625
6AK5	256
Misc	400 (approx)

Approximately 45 tube types, including power supplies, etc.

Diodes	
Germanium	24,000 (approx)
Several types	
Delay lines	850 (approx)

CHECKING FEATURES

Fixed

Parity check for acoustic storage.

Parity check for electrostatic storage.

Optional

"AUTOMONITOR" - Order by order and breakpoint monitoring of program progress available to operator by console switch setting. Address in memory, instruction being performed and its result may be printed on Flexowriter, punched paper tape, magnetic wire or tape automatically.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	25 KVA
Power, air conditioner	5.76 Kw 7.2 KVA 0.80 pf
Volume, computer	680 cu ft
Area, computer	85 sq ft
Volume, air conditioner	77 cu ft
Area, air conditioner	17 sq ft
Weight, computer	3,000 lbs (Central Machine)
Weight, air conditioner	1,500 lbs.

Dimensions of computer are 5 x 17 ft. Air conditioner measures 77 x 31 x 56 inches. Floor space for computer control console, memories and auxiliaries is 1,386 sq. ft. Floor space for air conditioner and power supplies is 225 sq. ft.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

PERSONNEL REQUIREMENTS

Since SEAC is being used as a research tool rather than for computation, it is not used on a regularly scheduled basis. Training of programmers is done internally within the user groups. Available only to Government agencies.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	3 hours
Good time	4,877 hours
Attempted to run time	5,786 hours
Operating ratio (Good/Attempted to run)	0.83
Figures based on period 26 Aug. 55 to 14 Sep. 56	
Acceptance test	May 1950

The above figures are for system reliability and include the SEAC and all its auxiliary equipments.

Basic building block is well-designed pulse repeater stage of excellent reliability. Plug in pulse transformers, gating diodes and electrical delay lines simplify maintenance problems. Heat producing elements are mounted on same side of vertical chassises in cooled airstream. All signals are ready accessible for oscilloscope monitoring.

When computer was in operation 20 hrs/day, 7 days a week, with 4 hrs. for preventive maintenance, high speed circuitry was approximately 95% reliable. Overall system 85% - 95%. Computer is now 10 years old and with reduced demands and maintenance staff this figure must be de-rated somewhat.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a variety of auxiliary devices, automonitoring of program, ease of "talking" with the machine, and two counter registers which may be used for program sequencing and address base numbers. See DYSEAC also.

FUTURE PLANS

Possibility exists for adding 1,024 words of acoustic delay line memory to be used as parallel access memory for activating display devices. In combination with the existing machine features this will greatly aid continuing work in character recognition studies.

INSTALLATIONS

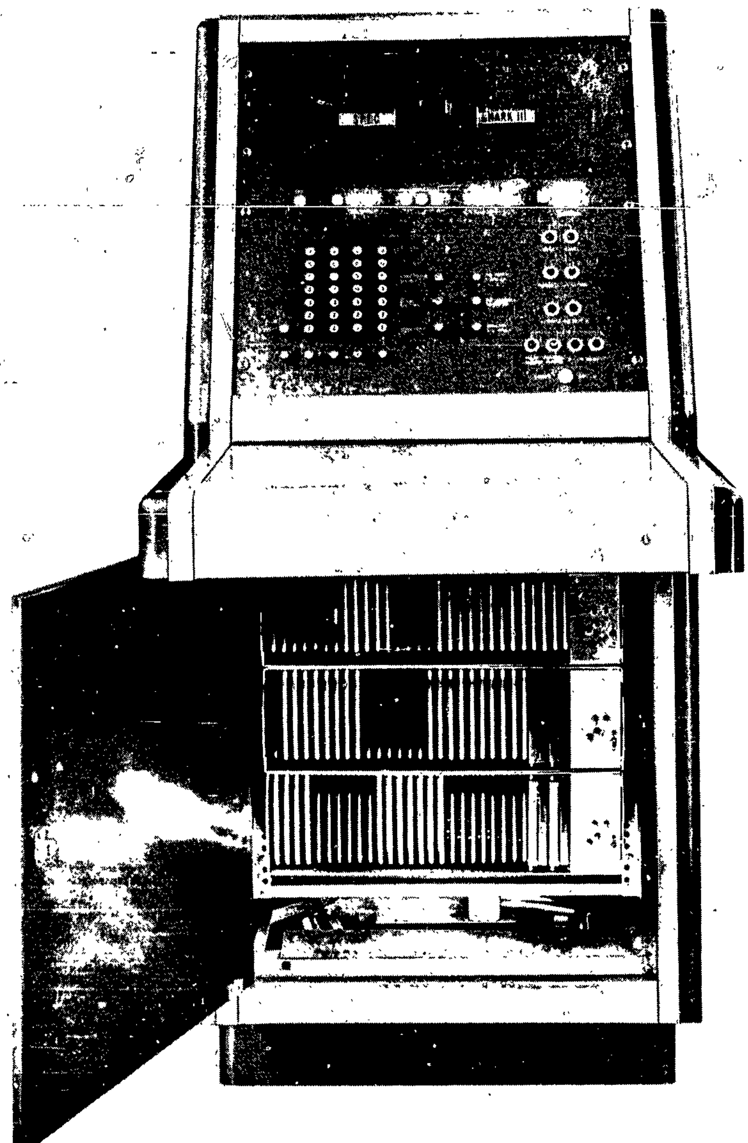
National Bureau of Standards
U. S. Department of Commerce, Washington 25, D. C.

SPEC

SPEC Mark III Computing System

MANUFACTURER

Computer Control Company, Incorporated



Front

Photo by Computer Control Company, Inc.

APPLICATIONS

System is designed and used for teaching machine operation and basic programming techniques, teaching logical design, general purpose computation, the solution of differential equations, and for the rapid implementation of special logical systems.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	13
Binary digits/instruction	13
Instructions per word	One
Instructions decoded	8
Arithmetic system	Fixed point
Instruction type	One address
Number range	- 4095 to + 4095

Photo by Computer Control Company, Inc.

Instruction word format

13	12 11	10 4	3 1
Sign	Unused	Address	Operation Code

The above information applies to SPEC as a general purpose computer. As a digital differential analyser, SPEC has 20 integrators, a 21 bit word length, and is a binary, stored program machine.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	221	13

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

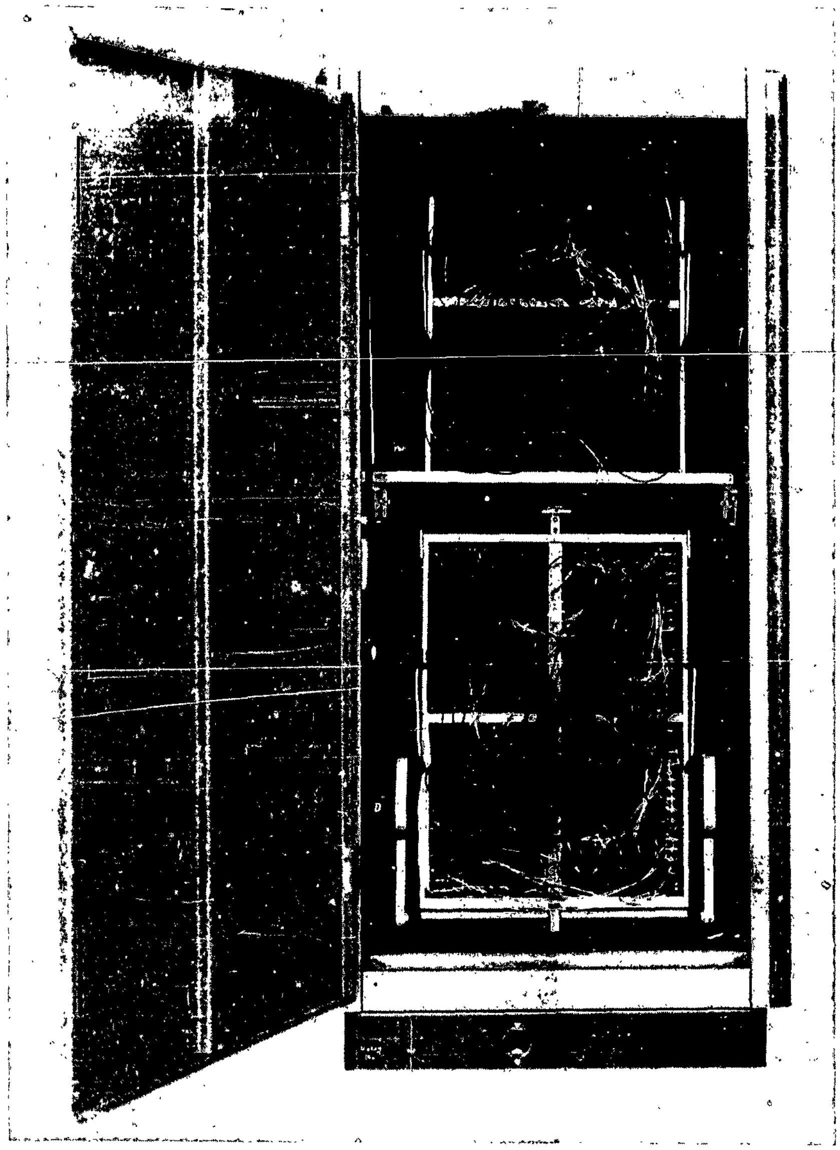
Media	No. of Words	No. of Bin Digits	Access Microsec
Magnetostrictive Delay Line	128 (GPC)	13	208 (Avg)
Magnetostrictive Delay Line	20 (DDA)	21	

GPC - General Purpose Computer
DDA - Digital Differential Analyzer

Four 416-bit delay lines are available, in which words of almost any length may be stored merely by making appropriate changes in the logical wiring.

INPUT

Octal Keyboard. Speed depends on operator's skill.
System input is adaptable to punched paper tape input.



Rear

Photo by Computer Control Company, Inc.

OUTPUT

Media	Speed
Register Indicator Lights For both GPC and DDA	
Analog Output (for plotter) DDA only	
Digital Output (incremental for plotter) DDA only	Up to 200 points/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	1,617
Transistors	279

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.06 Kw
Volume, computer	19 cu ft
Area, computer	4.52 sq ft
Floor loading	68.5 lbs/sq ft 77.5 lbs concen max
Weight, computer	310 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	0
Number in current production	4
Number on order	4
Time required for delivery	3 months

Four are on order to Redstone Arsenal

COST, PRICE AND RENTAL RATES

Mark I	Model	$17,695.00
Mark II	Model	19,195.00
Mark III	Model	24,895.00

ADDITIONAL FEATURES AND REMARKS

The entire logical wiring is on removable patchboard, which facilitates quick change from general purpose computer to digital differential analyzer or utilization for logical implementation. The system allows the student or user complete freedom in logical design study without any possibility of equipment damage due to incorrect wiring.

The SPEC (stored program educational computer) is available in three models:

Mark I - General purpose computer only
Mark II - Digital differential analyzer only
Mark III - General purpose computer, digital differential analyzer, universal logic implementer.

Only Mark III has logical wiring on patchboard and may be converted from GPC to DDA merely by interchanging two prewired patchboards. Other arrangements of components may be accomplished by appropriate wiring of other patchboards. Components of SPEC are Computer Control Company's standard plug-in digital modules.

INSTALLATIONS

Computer Control Company, Inc.
Western Division
2251 Barry Avenue
Los Angeles 64, California

Redstone Arsenal
Huntsville, Alabama

STORED PROGRAM DDA

Stored Program Digital Differential Analyzer

MANUFACTURER

International Business Machines Corporation
Federal Systems Division

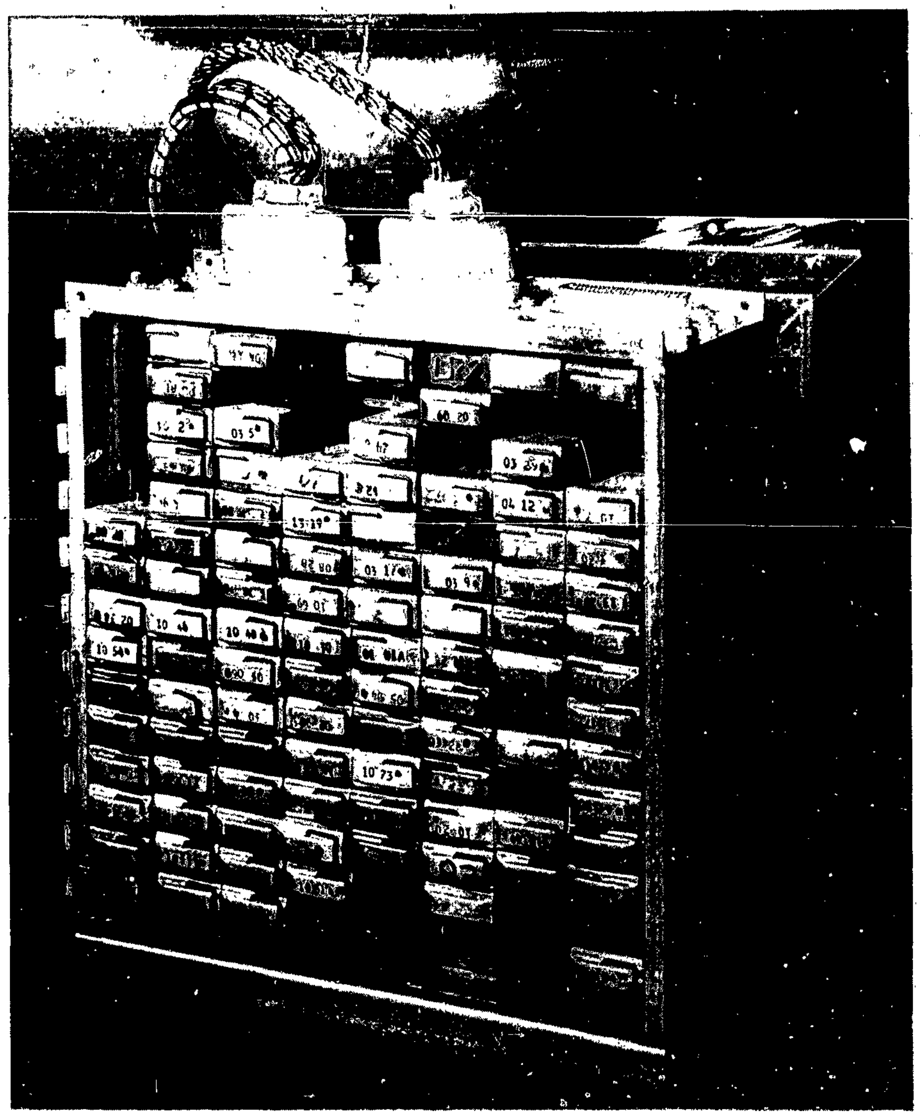


Photo by International Business Machines Corporation, Federal Systems Division

APPLICATIONS

Computing system is used for missile guidance and the simulation of complex weapons systems by a real-time tie-in to an IBM 704 E. D. P. M.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	nominally 22 bits
Binary digits/instruction	4
Instructions per word	5
Instructions decoded	365 (16 basic)
Arithmetic system	Fixed point
Instruction type	Transfer direction - "To" and "From"

Instruction word format

"From" Word	1	2	3	4	. . . .	19	20	21	22
"To" Word									
	Instruction Word Lengths							Two Bit Word Control	

The organization of the computer will allow various trade-off possibilities between number of integrators, accuracy and solution rates. For example, a solution rate of approximately 33,000 iterations per second can be achieved in generating a sine-cosine function with an accuracy of 1 part in 2^{15}. On the other hand, a problem requiring 300 integrations with the same accuracy can be solved at a rate of 220 iterations per second. Program is defined as for an IBM 704 System.

ARITHMETIC UNIT

Integration	22 Microseconds
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential
Nominal standard mode	
Iteration Rate	623 Solutions/sec
Capacity	73 Integrators (w/22 bit words)
Bit Rate	1 megacycle

Arithmetic mode can be selected to operate in a standard mode. Rate mode ($623/21 \times 2^N$ iterations/sec) or Number Mode (21×2^N), where $0 \leq N \leq 5$.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetostrictive Delay Line	219	3,358	22

INPUT

Media	Speed
Toggle Switches	
Cards (IBM 402)	240 words/sec
I/O Register	625 words/sec

The I/O Register is used with Tie-in to the IBM 704 EDPM. Automatic programming by the IBM 704 EDPM can be coded into cards which can be loaded into the DDA via the card feed unit.

OUTPUT

Media	Speed
Pulse Motor	40 pulses/sec (bidirectional)
Neon Lights	(For online checks)
I/O Register	625 words/sec (DC Analog Computer)
Pulse Motor	240 pulses/sec (Omni-directional)

The I/O Register is used with Tie-in to an D-C Analog Computer to provide an analog display on an X-Y coordinate Variplotter, and/or in a solution to a simulation problem requiring both analog and digital computations. Neon lights are used for digital display. Pulse motors are used as direct outputs from the DDA computer, which, in turn, can be used to control potentiometer settings for control of an analog plant.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	
DDA System		
Diodes	886	(T-16G Germanium)
Transistors	309	(Microalloy Drift Germanium)
Control Unit for 704 Tie-in		
Transistors	400	(MADT)
	30	(GE 396)
Diodes	1,133	(T16G)
Total Components (with 704 Tie-in)		
DDA Computer	3,114	
704 Tie-in Control Unit	4,675	
Control Unit for ASM application		
Transistors	220	(MADT)
Diodes	504	(T166)

Circuits have been packaged for ground base military operation or airborne applications using either germanium or silicon transistors.

CHECKING FEATURES

Manual operation in observing results of simulated problem is possible for performing checking operations. Checks are visual - sine-cosine generation, problem reversal, and pre-computed accuracy at a given time from a reference.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.029 Kw
Volume, computer	0.73 cu ft
Area, computer	0.75 sq ft
Weight, computer	30.5 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	4 months

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Programmers	1/4 - 1
Technicians	1/2

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Circuit designs include, 100,000 hour reliability, noise rejection (33% to 40% of signal), environmental tests Mil-E-S272-A and radiation tests (integrated flux $\approx 3 \times 10^{13}$ neutrons/cm^2). Packaging techniques include welded encapsulated modules, cube pack, and printed circuit cards. The estimated Mean-Time between Failures (EMT) is 2,855 hours.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a variable solution rate mode. Unique system advantages include automatic 704 programming and computer flexibility for binary or ternary increment transfer. Tie-in to IBM 704 EDPM and D-C Analog computer will provide problem solutions requiring both full value and incremental techniques, and permit investigation of computer communications.

FUTURE PLANS

Plans include an increase in speed and a reduction of circuit costs by a factor of 3.

SWAC
NBS Western Automatic Computer

MANUFACTURER
National Bureau of Standards

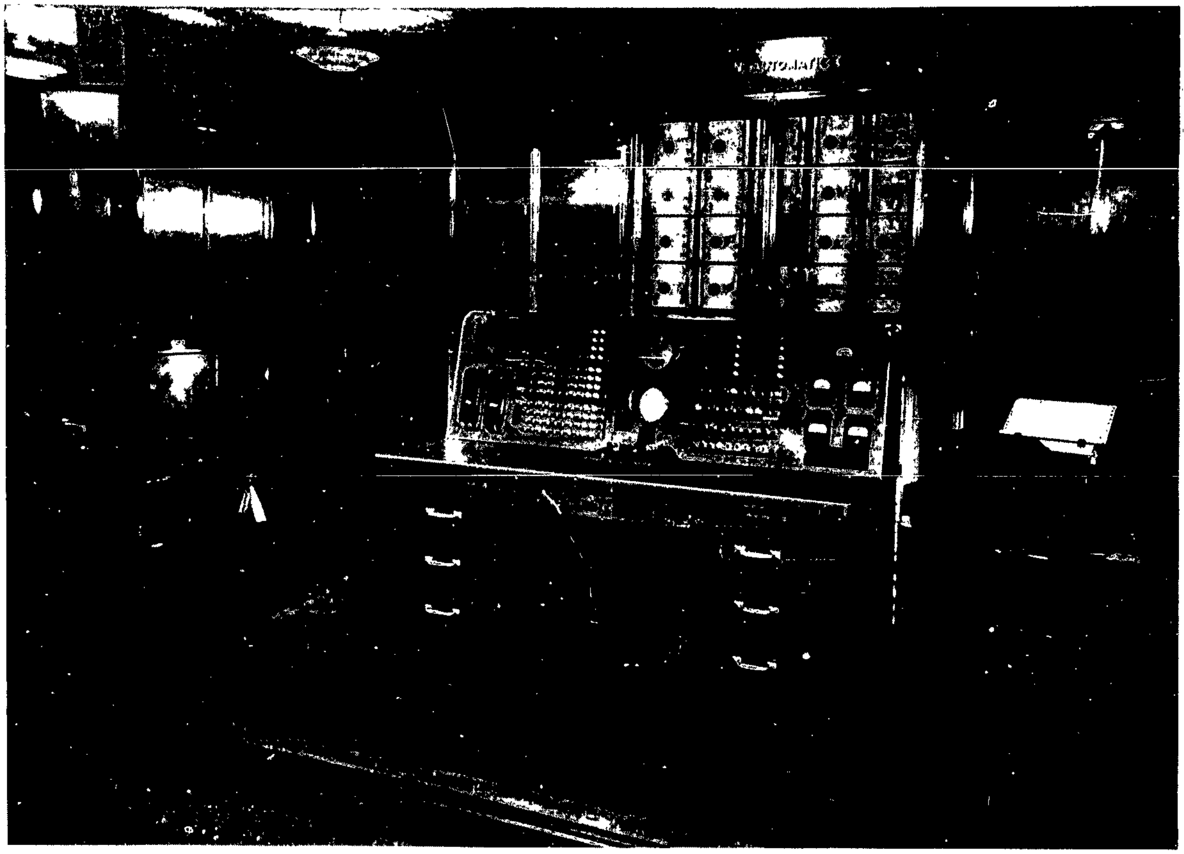


Photo by National Bureau of Standards

APPLICATIONS

General purpose scientific computation, research in numerical analysis computing methods.
The National Bureau of Standards Western Automatic Computer (Originally the "Zephyr", known as SWAC).
A medium-sized, high-speed computer with 256 word electrostatic (Williams type) memory, and an 8,192 word drum storage. The machine is described in the IRE, Proceedings, Computer Issue, 1953.
Some applications of SWAC includes the study of discrete variable problems. The use of diffuse surface optical model of the nucleus in the analysis of elastic scattering of charged particles by complex nuclei. The analysis of the crystalline structure of vitamin B12. Determination of many of the larger prime numbers. Valuable work on semi-groups, traffic simulation, the growth of cloud drops, counter gradient methods, queueing theory, and on correlation and factor analysis in psychology.
The SWAC is used as a training tool and as a prototype for computer study in courses of the UCLA curriculum. Its increased use as a data translator is contemplated if the University acquires another high speed computer. Some data conversion is now done on SWAC in connection with problems to be solved on the WDPC 709 computer, operated on campus under the direction of the Department of Business Administration.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	37 incl. sign
Binary digits/instruction	36
Instructions/word	1
Instructions decoded	13
Instructions used	13
Arithmetic system	Fixed point
Instruction type	Four address
Number range	$-(1 - 2^{-36})$ to $+(1 - 2^{-36})$

Binary point lies between sign and most significant digit. Arithmetic is done with absolute value and sign. The fourth address controls an optional jump and selects the auxiliary devices.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	64	5.3
Mult	368	296
Div	Not a logical operation	

Construction 9 tubes/register
Rapid access word registers 3
Basic pulse repetition rate 125 Kc/sec
Arithmetic mode Parallel
Timing Synchronous
Operation Sequential

Auxiliary equipment asynchronous, computer halts and waits for signal. The storage access time includes the 4th address reference. There are 37 parallel registers in the arithmetic unit (three input adders). System uses simultaneous carry and static storage of the addend and the augend. Germanium diodes (semi-conductors) for logical "and" and "or" circuitry.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Electrostatic (CRT)	256	9,984	8
Magnetic Drum	8,192	311,296	17,000

The regeneration time on the electrostatic storage unit is 8 microseconds. The drum access time is given for a 64-word block transfer. The drum transfers in blocks of 64, 32, 16 or 8 words. Average time of transfer for less than a 64 word block is 13,000 microseconds. A magnetic core memory of 512 words has been built to replace the present 256-word electrostatic store, and it is currently planned to attach two magnetic tape units of 150 inch/second read-record speed.

INPUT

Media	Speed
Punched Cards (IBM)	240 cards/min
Keyboard	Manual

Eleven words may be punched on each card. The keyboard is adapted for code checking. Peripheral equipment includes IBM punched card reader, card punch, and EAM printer, for on-line use, and a typewriter. The usual card preparation equipment forms part of the installation.

OUTPUT

Media	Speed
Punched Cards	100 cards/min
Tabulator (IBM 402)	80 lines/min
Typewriter	30 words/min

Twenty-four words per card may be punched on output. The tabulator is a decimal output device, printing 72 characters per line.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes 2,500
Crystal diodes 4,000

CHECKING FEATURES

Fixed
No interlocks or transfer checks are used.

Optional
Parity check on drum transfers is controlled by a toggle switch. Breakpoints may be stored on non-commands to halt machine when loss of control occurs.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer 30 - 35 Kw
Power, air conditioner 20 HP
Capacity, air conditioner Two 10-Ton units and a 5,000 cu ft/min fan

PRODUCTION RECORD

Number produced 1
Number operating 1

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $400,000
Rental rates for additional equipment
IBM equipment $750/month

The rental charge for use of the computer and auxiliary equipment is $40/hour. The rental rate does not apply to use of peripheral equipment when not connected to the computer. Such additional use is free.

PERSONNEL REQUIREMENTS

The personnel requirements for maintenance consist of one full time supervisor, one full time principal electronics technician, and two half-time technicians recruited from the students.

The programming is done mostly by the users of the machine, in "open-shop" style, but there are a programming supervisor, one full time, and one half-time systems programmers.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period 25 Minutes
Good time 796 Hours
Attempted to run time 938 Hours
Operating ratio (Good/Attempted to run time) 0.85
Figures based on period 1 Apr 56 to 30 Jun 56
Passed Customer Acceptance Test Mar 51

ADDITIONAL FEATURES AND REMARKS

The SWAC was moved during the period from September 1959 to June 1960, from quarters in a temporary building to a permanent site in one of the Engineering buildings on campus. While the move was underway modernization of the power equipment was undertaken, primarily to replace obsolescent equipment with new. The console was modernized with the addition of a portable keyboard permitting remote operation of the computer for instructional purposes. The drum, which had been in operation since January 1956, was rebuilt with new bearings, and the surface turned down. A new air-conditioning plant was installed. The computer was debugged by September 1, 1960, and has been operating regularly since that date. Its reliability is better than before the move, but by how much will have to be determined by the performance records of the next few months.

INSTALLATIONS

Department of Mathematics, Numerical Analysis Research
University of California
Los Angeles 24, California
(Sponsored by: Office of Naval Research and Office of Ordnance Research)

SYLVANIA S 9400

Sylvania Model S9400 ADPS

MANUFACTURER

Sylvania Electric Products, Incorporated

APPLICATIONS

The Sylvania 9400 Data Processing System has been designed as a general purpose computing system with built-in real time applications ability. The computer is capable of handling the largest of the commercial type data processing problems and is equally at home when working on the most sophisticated scientific problems.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	37
Binary digits/instruction	37
Instructions per word	1
Instructions decoded	64
Arithmetic system	Fixed and floating point
Instruction type	Modified single address
Number range	$-2^{242} + 2^{255}$ -1×2^{-256} $+1 \times 2^{-256}$ $+(2^{242} - 2^{255})$

Instruction word format

OP		1		M		A	
1	6	7	9	10	21	22	36

Automatic built-in subroutines include clear memory.
Automatic coding includes COBAL, ALGOL, 94AP.
Registers and B-boxes
Arithmetic Registers
Accumulator
B Auxiliary Register of the Arithmetic Unit
Q Used during multiplication and division
P/C Program Counter to count steps of Program
P/C facilities return from sub-routines
Index Registers
Instruction Register
Address Register
X Register
G Register
Error Alarm Register
Real Time In
Real Time Out
Control Register
Decoder Register

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	8	4
Mult	43	39
Div	44	40

Construction (Arithmetic unit only)

Vacuum-tubes	None
Transistors	13,507
Condenser-diodes	5,565

STORAGE

Media	No. of Words	No. of Bin/Dig	Access Microsec
Magnetic Cores	32,768	38	4
Random Access Disc	6,000,000		200,000

Magnetic Tape

No. of units that can be connected	64 Units
No. of char/linear inch of tape	600 A/N Char/inch
Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	1 Inch
Tape speed	150 Inches/sec
Transfer rate	90KC A/N Char/sec
Start time	3 Millisec
Stop time	1.5 Millisec
Average time for experienced operator to change reel of tape	45 Seconds
Physical properties of tape	
Width	1 Inch
Length of reel	3,600 Feet
Composition	Mylar

INPUT

Media	Speed
Magnetic Tape	90,000 char/sec
Card Reader	2,000 char/min
Paper Tape	270 char/sec
Real time	120,000 char/sec

OUTPUT

Media	Speed
Typewriter	10 char/sec
Magnetic Tape	90,000 char/sec
Paper Tape Punch	100 char/sec
Card Punch	250 char/min
Printer	900 lines/min 120 char/line 64 printing characters

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type		
Tubes	None	
Diodes	2,000	Varies depending on system configuration
Transistors	36,000	Varies depending on system configuration
Magnetic cores	1,319,920	This includes buffers for I/O devices.

CHECKING FEATURES

Internal parity
Marginal checking capabilities

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	20 KVA	0.9 pf
Volume. computer	2,220 cu ft	
Volume, air condi	150 cu ft	
Area, computer	360 sq ft	
Area, air conditioner	15 sq ft	
Room size, computer	1,200 sq ft	
Room size, air condi	30 sq ft	
Floor loading	175 lbs/sq ft	
	1,000 lbs concen max	
Capacity, air conditi	10 Tons	
Weight, computer	21,825 lbs	

Minimum preparation is required for the system. It is desirable to install a raised floor to allow the cables to be buried out of the way. The S-9400 operates on 208 volt, three phase, 4 wire, 60 cycle power supply. Line voltages must be maintained plus or minus 10%.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	4
Number on order	2
Time required for delivery	12 months

Training of programming analysts and operators provided, either at manufacturer's training center or at customer's installation.

This system has entered system tests.

COST, PRICE AND RENTAL RATES

Description	Model No.	Monthly Rental	Purchase Price	Monthly Maintenance
ON-LINE SYSTEM UNITS				
Central Processor Includes	9401	$16,500	$825,000	$1,110
Arithmetic and Control Unit				
Console and Output Typewriter				
Floating Point				
Power Supply				
32,768 Word Memory	9432	12,500	625,000	633
16,384 Word Memory	9416	9,400	470,000	475
Input-Output Processor	9410	2,750	137,500	140
Magnetic Tape Unit	9490	950	47,500	185
High-Speed On-Line Printer and Buffer	9440	3,200	160,000	610
Disc Storage Unit & Buffer:				
20 Million Char. One Address Register	9452	5,640	282,000	1,340
80 Million Char. One Address Register	9453	6,800	340,000	1,750
20 Million Char. Three Address Registers	9450	6,720	336,000	1,340
80 Million Char. Three Address Registers	9451	8,840	442,000	1,750
Card Reader Punch & Buffer 100-100 cpm	9481	850	42,500	90
Card Reader Punch & Buffer 800-250 cpm	9482	2,250	112,500	380
High-Speed Card Reader & Buffer 2000 cpm	9486	2,400	120,000	550
Paper Tape Reader & Punch System	9460	1,200	60,000	276
Real Time System	9415	760	38,000	50
OFF-LINE SYSTEMS				
High-Speed Paper Tape to Magnetic Tape System Includes:	9465	4,140	207,000	925
Magnetic Tape Unit				
Buffer & Control Unit				
2 Paper Tape Readers (1000 cps)				
High-Speed Off-Line Printer System Includes:	9445	5,750	287,500	1,195
Magnetic Tape Unit				
Buffer & Control Unit				
High-Speed Printer				
High-Speed Card to Magnetic Tape System Includes:	9485	5,200	260,000	1,135
High-Speed Card Reader (2000 cpm)				
Buffer & Control Unit				
Magnetic Tape Unit				

ADDITIONAL FEATURES AND REMARKS

Outstanding features are functional modularity, moderate size, low power and air conditioning requirements, high speed, flexibility, real time, the ability to work with a large number and a wide variety of I/O devices, scatter read/write, and read tape reverse.

Large computer systems such as this one are seldom duplicated from one installation to another. Individual problems and applications require unique configurations and special features that establish either purchase or lease price. Upon completion of a feasibility study, when the requirements are known along with a calculated growth, costs could be determined.

SYLVANIA UDOFTT

Sylvania Universal Digital Operational Flight Trainer Tool

MANUFACTURER

Sylvania Electric Products, Incorporated

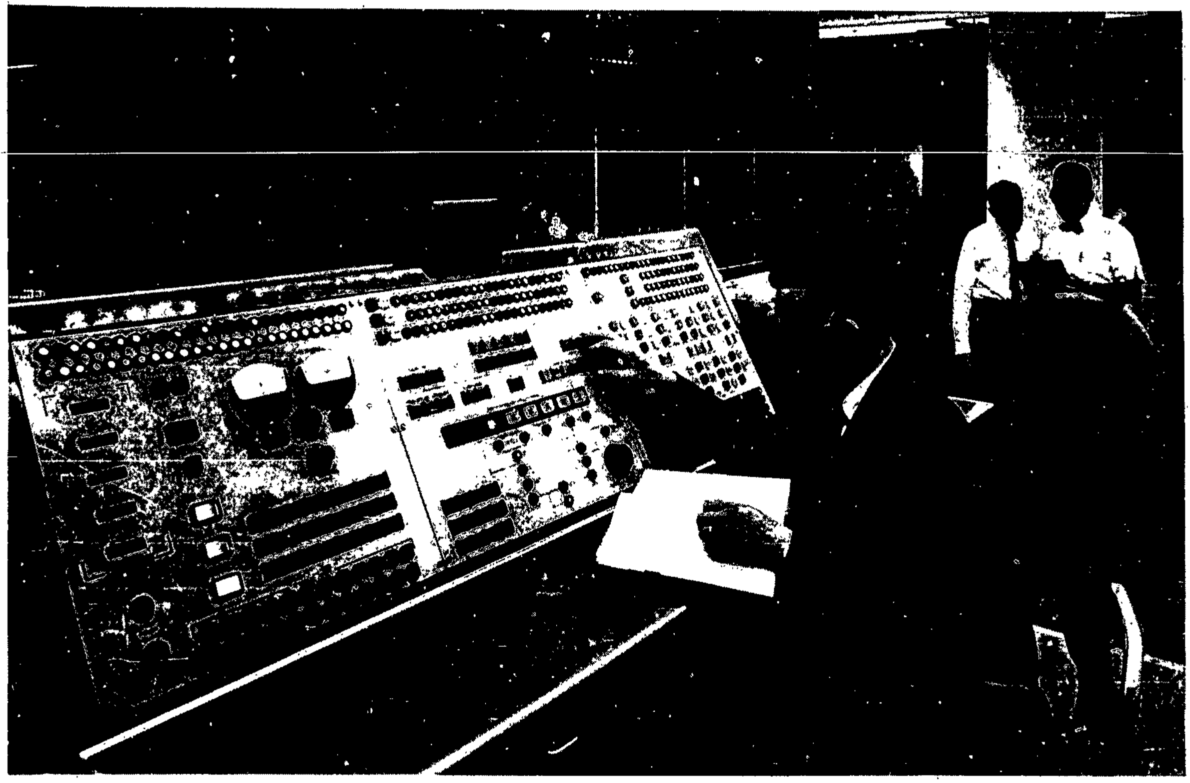


Photo by U. S. Naval Training Device Center

APPLICATIONS

Manufacturer

UDOFTT (Universal Digital Operational Flight Trainer, Tod) represents the first application of a high-speed, general purpose digital computer to real-time control of operational flight trainers. Developed by Sylvania under contract with the U. S. Naval Training Device Center, UDOFTT is presently being used as a research tool upon which extensive mathematical investigations relative to real-time simulation will be conducted.

As a joint Navy and Air Force project, the first UDOFTT system has the capability of simulating Navy Sub-Sonic and Air Force Super-Sonic jet aircrafts. To accomplish simulation of actual aircraft flight, UDOFTT consists primarily of three units:

Stored program digital computer
Aircraft cockpit mockups
Instructors' consoles

Through the use of a stored program digital computer, simulation of different aircraft can be accomplished by merely changing the computer program. The exploitation of this flexibility is the key to the realization of the full advantages of digital over analog systems as operational control elements.

Basically, a high speed, general purpose digital computer, UDOFTT represents an advancement in the design of real-time control computers. Using dual 4096-word random access core memories, the basic order time for UDOFTT is five microseconds with the result that a complete addition, including memory access time, can be accomplished in the five microsecond interval.

Containing actual aircraft controls, the cockpit is connected to the computer portion of UDOFTT so that actuation of the controls and instruments will give the appearance of actual flight.

Consisting primarily of a duplication of the instruments contained in the aircraft cockpit, the instructor's console is used to monitor aircraft performance. It can also be used for the insertion of emergency situations such as engine failure, fires, rough air, and many others.

Developed as a research tool for evaluation and testing of digital computers for flight simulation, UDOFTT is equally adaptable to such simulation functions as space vehicles, submarines and testing of flight dynamics.

A study has been conducted for the U. S. Naval Training Device Center on a transistorized successor to UDOFTT. As a result, future digital computers for real-time control systems may be reduced to 40

cubic feet and may be adapted to either fixed site or vehicular mounted applications.

U. S. Naval Training Device Center
The system, located at the U. S. Naval Training Center, Simulation Computer Lab., 605 Stewart Avenue, Garden City, N. Y., is used for the investigation of the application of high speed digital electronic data processing machines to real time training and simulation problems of the military services. The initial phase concerns the application to the operational flight trainer (flight simulator) problem utilizing the F9F-2 and F100A cockpits and programs. Problems to be considered are the optimum mathematical formula for numerical integration, standardization of programming procedures, trainer maintenance and logistic requirements and human engineering aspects of the equipment and utilization of the equipment. Additional uses involve the application of the system to the real time solution of simulation problems of submarines, surface and space vehicles for analysis and training.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20 plus sign plus parity check bit
Binary digits/instruction	19 plus parity check
Instructions/word	1
Instructions decoded	28
Arithmetic system	Fixed point
Instruction type	One address
Number range	$(1 - 2^{-20})$ to $-(1 - 2^{-20})$

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add time	5
Mult time	10
Div time	105

Construction
Vacuum tubes and crystal diodes

Arithmetic mode	Sequential - parallel
Timing	Synchronous
Operation	Sequential

The system utilizes sequential-parallel operation using serial synchronous circuits. Construction of the arithmetic unit is similar to the SEAC System. Employs W.E. type 404A tube. Some transistors are used. A 5 phase clock source is used. Clock rate is 1.2 microseconds.

STORAGE

USN TDC

Media	No. of Words	No. of Binary Bits	Access Microsec
Instruction Memory Magnetic Core	4,095	20	5
Number Memory Magnetic Core	4,094	22	5

The storage system consists of two separate units: 4,094 number words and 4,095 instruction words. Both units require an access time of 5 microseconds while the arithmetic unit is operating on the previous instruction.

INPUT

USN TDC

Media	Speed
Punched Cards	500 words/min
Analog Input: Gray code shaft converters	10 microsec
Switches (console)	Manual
Discrete Input Switches	5 microsec

Punched cards are used only at start of simulation to load the memories. 64 discrete input switches are available as inputs from the cockpit and instructor's console. Analaog and discrete switches are initiated by pilots controls and flight instructor inputs.

OUTPUT

USA TDC

Media	Speed
Facility for binary printer	
Electric Typewriter	10 lines/min
Analog Output	100 microsec
Discrete Output	5 microsec

Analog and discrete outputs provide voltages to actuate pilots instruments and indicators.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	1,800
Tube types	3
Crystal diodes	20,000
Magnetic cores	180,224
Transistors	500

Above figures are approximate. A tube type utilized is the 404A.

Separate cabinets 6 (not including A-D conversion equipment)

CHECKING FEATURES

Parity, marginal, overflow, unused order type
Slow computation switch and one cycle operation for program check and calibration.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

USN TDC

Power, computer	24 Kw	30 KVA	0.8 pf
Power, air conditioner		40 KVA	
Volume, computer		1,350 cu ft	
Volume, air conditioner		350 cu ft	
Area, computer		160 sq ft	
Area, air conditioner		50 sq ft	
Room size, computer		30 ft x 40 ft	
Room size, air conditioner		12 ft x 22 ft	
Floor loading		135 lbs/sq ft	
		175 lbs concen max	
Capacity, air conditioner		40 Tons	
Weight, computer		22,000 lbs	
Weight, air conditioner		5,000 lbs	

Conditioned air distribution to computer area. 100 KVA electrical service. Data does not include cockpits and utility power.

PERSONNEL REQUIREMENTS

USN TDC

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Programmers	2	2
Engineers	2	2
Technicians		2

Operation tends toward closed shop.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USN TDC

Average error-free running period 5 - 6 Hours
Good time 32 Hours/Week (Average)
Attempted to run time 33 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period 1 Jan 60 to 1 Apr 60
Passed Customer Acceptance Test 1 Apr 60
Time is available for rent to qualified outside organizations.

Time may be made available to federal orvernment organizations for the solution of real-time simulation and training problems.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Ultra high speed is achieved through a novel logical structure. System includes an interval timer of great flexibility for real-time simulation.

USN TDC

The system solves in real time complete aerodynamic, engine and systems equations, in flight and on ground, for either the F9F or the F100A aircraft. A complete solution of the equation in less than 50 milliseconds permits a 20 cycle/second solution.

FUTURE PLANS

USN TDC

Future models to be transistorized and possibly mobilized. Has possibility of simulating more than one cockpit simultaneously.

INSTALLATIONS

U. S. Naval Training Device Center
Port Washington, New York

TARGET INTERCEPT

Target Intercept Computer (TIC)

MANUFACTURER

Remington Rand Univac Division
Sperry Rand Corporation

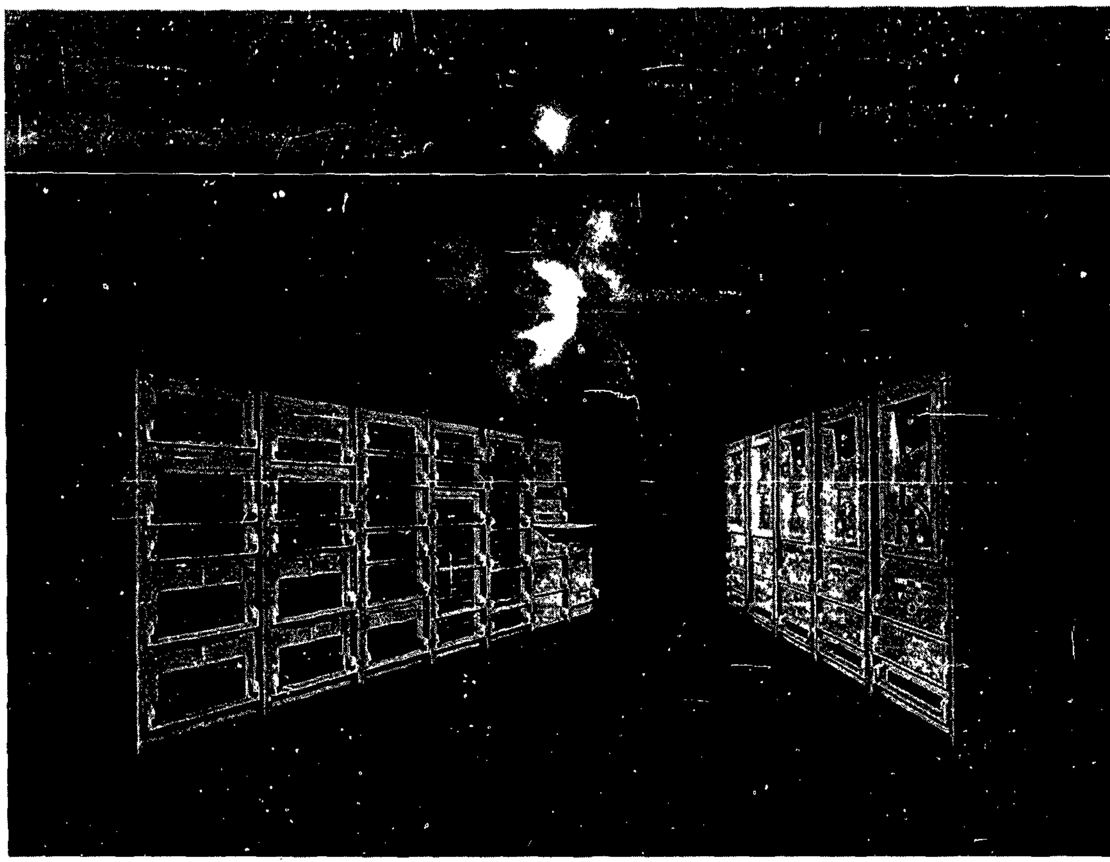


Photo by Remington Rand Univac

APPLICATIONS

System is used for missile guidance in real time (on-line), system simulation, data processing, and automatic coding (Autocode).

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	24
Binary digits/instruction	24
Instructions/word	1
Instructions decoded	35
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-1 \leq X < 1$ and, in R Memory
	$0 \leq X < 2^{14}$ (integer addresses)

Instruction word format

Op Code	j Factor	Operand	Parity
0 5	6 9	10 23	24

Shift Instruction						
Operation Code	J Factor	Not Used	Shift Control	Not Used	Shift Count	Parity
0 5	6 9	10 11	12 17	18	19 23	24

Automatic built-in subroutines include error checking, system diagnosis, and program sequence control.

Automatic coding includes special Autocode programs.

Registers includes fifteen 15-bit registers, referenced by j factor.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	10	5
Mult	25	20
Div	45	40

Construction (Arithmetic unit only)

Transistors 6,200 (approx) includes Arithmetic Sequence Control

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

An overlapping instruction repertoire, plus the ability to simultaneously execute arithmetic and non-arithmetic sequences, causes certain operations in the computer to be concurrent.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Permanent (Z) Memory	10,240	25	2.8
Variable (O) Memory	2,048	25	2.2
Reference (R) Memory	15	14	0.9
Real-Time (Z) Memory	48	25	2.8

Magnetic Tape

No. of units that can be connected	5	Units
No. of chars/linear inch of tape	200	Chars/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating each record	3/4	Inches
Tape speed	150	Inches/sec
Transfer rate	30,000	Chars/sec
Start time	3.9	Millisec
Stop time	0.7	Millisec
Average time for experienced operator to change reel of tape	15-30	Seconds
Physical properties of tape		
Width	0.5	Inches
Length of reel	2,400	Feet
Composition	1.5 mil mylar, polyester backing	

Start time Write 4.3 millisec
Stop time Write 0.7 millisec + 3=8 millisec total start-stop time.

Start time Read 3.5 millisec
Stop time Read 0.68 millisec + 7.2 millisec total start-stop time.

In both write and read operations, this 3 millisecond interfunction relay must be added to obtain total start stop time.

INPUT

Media	Speed
Flexowriter, Model Fl Automatic Typewriter	8 chars/sec
Ampex FR 307 Magnetic Tape Units	30 KC

Six alphanumerics is equivalent to 1 character. Flexowriter and Ampex units are specially adapted.

OUTPUT

Media	Speed
Flexowriter, Model Fl Automatic Typewriter	8 chars/sec
Ampex FR 307 Magnetic Tape Units	30 KC

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	1,344
1N98	
1N2146	
Transistors	
2N559	20,000
Magnetic Cores	
General Ceramics	
5040-A	37,584

All words and parity in the Permanent (Z) Memory (256,000 digit locations) are stored in alnico magnets that are imbedded in Special Program cards.

CHECKING FEATURES

Program indicates and analyzes all detectable errors. Parity checking on data transfers, address transfers, and word locations. Also checked on overflows, critical commands, timing, program sequences, input/output and operator errors. Routines for extensive exercising and checking can be run at the discretion of the operator.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	2.5 Kw	2.5 KVA 1 pf
Volume, computer		210 cu ft
Area, computer		69.5 sq ft
Room size		36 ft x 10.5 ft minimum
Floor loading		150 lbs/sq ft
Weight, computer		5,200 lbs

Installation must meet all normal requirements of cleanliness; a normal working environment is satisfactory for the computers; i.e., its operating range is between 60° and 100°F (16-38°C). Air-conditioning is provided, though not essential; forced-air cooling is the minimum requirement.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	1

PERSONNEL REQUIREMENTS

Written publications on description, theory, operation, and maintenance; orientation courses conducted by training department; staff of Field Service Personnel maintain computer at site.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability include:

- Computer isolates and indicates its own failures
- Error routine locates failed modules
- Failures indicated visually
- Non-redundancy of hardware
- Module layout by computer function
- Hardware detection of errors
- Program interpretation of and recovery from errors
- Permanent storage of critical instructions and constants.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include permanent storage of critical instructions and constants, overlapped instruction repertoire, automatic start of next program, interrupt control of scattering and gathering of data, and non-stop transfer of control an errors.

INSTALLATIONS

Remington Rand Univac
Univac Park
St. Paul 16, Minnesota

TELEREGISTER MAGNETRONIC BID ASKED

MANUFACTURER

Teleregister Magnetronic Bid-Asked Stock Quotation System

The Teleregister Corporation

APPLICATIONS

Data processing associated with stock exchange bid-asked price quotations

PROGRAMMING AND NUMERICAL SYSTEM

Binary digits per word 24

ARITHMETIC UNIT

Timing	Synchronous
Operation	Sequential

Five seconds of additional time are required for a transaction when input/output data are transmitted over teletype lines.

STORAGE

A single magnetic drum storage unit is utilized.
The drum capacity is 100,000 binary digits.
The system is designed to handle a maximum of 8 million average transactions/hour.
Relays are used for temporary storage of information.

INPUT

There are 200 special input/output devices located in Toronto, Canada. These are located near the printing mechanisms.
For remote locations, special transceivers are utilized to serialize and check data.

OUTPUT

Visual verification of input/output data (response) is possible at the originating input point.
Input error or data rejection is immediately signalled to the originating input device.
Automatic checking and data verification controls are built into the system.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Cost was dependent upon customer requirements.
System was installed but is not being maintained by the manufacturer.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Operating ratio (Good/Attempted to run time) 0.999

The system is operated on line 7 hours/day, 5 days/week.

ADDITIONAL FEATURES AND REMARKS

Special purpose system.
System is operated "on line" with current updating features.
Status reporting feature included.
Control is possible from all input transactions recording locations.
System incorporates remote control of the data processor from input/output stations.
The following is a technical, operational and historical description of the system:

The electronic equipment at the Toronto Stock Exchange represents the first use of electronic digital computer techniques for the storage and dissemination of stock quotations.

In 1937 The Teleregister Corporation installed for the Totonto Exchange an automatic, electro-mechanical system for displaying, storing and disseminating bid-asked prices on the more actively traded stocks. Bid-asked prices, generated at the trading posts on the floor of the Exchange from orders placed on the outside, were transmitted by reporters over an interphone system to keyset operators in the basement of the Exchange building. These keyset operators entered the bid-asked prices into the automatic system. The prices were displayed on electro-mechanical indicator units located at the posts on the floor for the information of the traders at that location. Simultaneously, the same prices were posted on indicators in a "check-board" located in front of the keyset operators.

The system also included a Canadian National Telegraphs network from the common equipment at the Exchange to broker' offices in the Toronto area, who were provided with dial-ticker units. A broker desiring the current bid-asked prices for a particular stock, looked up the three digit code number for the stock in a code-assignment register. When he was ready to dial, he pressed a request button on

his dial set. The operation of this button connected his dialing circuit and ticker line, through the line connecting equipment, to one of 24 transmitters which may be idle at the time. When the connection to the transmitter was completed, a ready lamp lighted on the broker's dial set, telling him that the equipment was ready to receive his dialing. The operation thus far is similar to that of a telephone exchange when the subscriber picks up the hand set and receives a dial tone. The dialed code numbers were stored in the transmitter, which was conditioned to extract the requested bid-asked price from the system's memory.

Up until several years ago the display indicators in the check board served a dual purpose in that they were also used as storage devices or memory units. These indicators were pulse actuated mechanisms which display the digits 1 through 0 and blank, on a 11-position rotatable drum. An indicator was set to display the desired digit by transmitting counted pulses to its winding after it has first been pulsed to its blank display position. In order to respond to a broker's dialed request, the indicators displaying the selected stock prices were actuated by exactly 11 pulses. This would leave the indicators in the same display position as before, but since it was possible to determine the number of pulses required to move each unit from its display position to its blank position, a coded readout of the stored prices was accomplished. These prices were then automatically sent by one of the 24 transmitters to a ticker at the calling broker's office.

After careful engineering analysis of the problem, it was decided to use electronic techniques and a non-volatile magnetic drum storage to process the 50,000 daily requests which were being received from broker's offices. Since the existing display posting system represented a major capital investment, it was necessary to integrate much of the old electro-mechanical system with the new electronic data processing equipment. This integration presented the major engineering problem, since the electronic components had already been developed and proven in service in an American Airlines reservation system, which processes an inventory of airlines seats in place of stock bid-asked prices. It was also decided to use the old price storage circuitry as a fall-back, so that a manual switch-over system had to be provided.

The magnetic drum storage equipment is time shared between the 24 transmitters and the 6 operators positions by the seeker equipment. The purpose of the operators' positions is to keep the prices displayed at the Exchange and stored on the magnetic drum up to date with the trading. The seeker is a relay switching device which connects the next transmitter or operator's position awaiting access to the drum storage, which is time-shared to all positions. When a transmitter gets access to the storage, the 3-digit code number, dialed by a subscriber and stored in the transmitter, is translated by the selector into the energization of one of 600 single-wire selection leads which were previously used to connect the transmitters to a specific section of the check-board display when that unit was used as the system's memory. In the new system these 600 leads are coded by use of a diode matrix with the position code of the same information on the magnetic drum storage. The output of the diode matrix is connected through drum selection coding relays to the drum connecting relays which, in turn, select one of 40 channels on the drum. If one of the six operators' positions has been given access to the storage drum, the electronic equipment is used to write the new price information stored on the operators' keyset in the section of the drum selected by one of 100 keys on the operators' keyset.

The magnetic storage unit consists of a solid aluminum billet, eight inches in diameter and fifteen inches high, coated with an iron oxide film about 0.003 inches thick. The drum has capacity for storing approximately two thousand sets of prices, six hundred being the initial usage. Prices are stored in permutation code on the drum coating as positively or negatively magnetized spots, the coding being changed as the prices alter. The drum is divided into circumferential tracks, or channels, each channel providing price storage for twenty-five stocks. The packing factor for this application is approximately 40 bits (or code elements) per inch along the track. A read-record head is mounted over each channel with a clearance of .001 inch from the drum surface. In recording, these heads polarize the magnetic coating as the drum rotates at a speed of 1,450 RPM beneath them, under control of electronic writing and gating circuits which are triggered off as the operators send in new prices. In a reading operation resulting from a broker's dialed request, the selected magnetized spots passing under the read-record head induce positive and negative pulses which are amplified and shaped into usable dynamic pulses.

The electronic equipment is under control of a program unit which is basically divided into seven circuits; starting, function determination, counting, 1 of 25 stock selection, 1 of 6 stock digit selection, read gating and write gating. Counting is in binary code and under control of three permanently magnetized tracks on the drum which are called synchronizing or "clock" tracks. These tracks deliver 1,256 and 600 pulses, respectively, for each revolution of the drum. The clock pulses to the electronic counters of the program unit open electronic gates at the precise instant that the desired storage area on the drum is passing beneath the selected read-record head. There is a reference pulse from the drum which assures that the electronic counting will always start in synchronism with the drum rotation. There are pulses which are used to select one or a combination of the six digits representing a bid-asked price. Since each price digit has a 4 element permutation code, there are 25 x 6 x 4, or a total of 600 storage bits in use on each drum track. The function of the shift registers is to read the amplified serial bid-asked price pulses from the drum and send the price in parallel to the transmitters, 24 elements at a time. In the case of a write operation, the shift registers control serial writing into the drum from parallel price code inputs from the operators' keysets. The electronic equipment contains approximately 400 tubes envelopes, of which about half are Western Electric 396-A twin triodes and the remainder Western Electric 415-A pentodes. A few 6Y6 tubes are used in the drum record circuits. All electronic components are mounted on functional plug-in sub-assemblies, using printed wiring techniques. An open construction is employed for better heat dissipation and lower operating temperature.

INSTALLATIONS

Toronto Stock Exchange
Toronto, Canada

TELEREGISTER MAGNETRONIC INVENTORY CONTROL

Magnetronic Inventory Control System

MANUFACTURER

The Teleregister Corporation

APPLICATIONS

Industrial inventory control
B. F. Goodrich Company, Footwear and Flooring Division
Finished goods inventory control

PROGRAMMING AND NUMERICAL SYSTEM

Binary digits per word	37

ARITHMETIC UNIT

Construction	Vacuum tubes
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

The time required for the completion of an average transaction from the completion of the input to the answer is 600 milliseconds. The system has a designed maximum capability of handling 6,000,000 average transactions per hour.

The operator has one master control panel for his use. A sub-supervisory control position is located at the data processor.

STORAGE

A single 1,500,000 binary digit capacity magnetic drum is utilized. The number of bits per standard item stored is 37 (comparable to a "word" in general purpose systems). Random access to the drum is possible.

The temporary storage medium is relays.

INPUT

One input/output device is located at the data processor.

One input/output device is located at the printing mechanism.

Paper tape is utilized as an input/output medium.

Electric office machines are controlled and driven by the system.

Punched cards are utilized.

B. F. Goodrich Company, Flltwear and Flooring Division

Tape reader speed is 10 char/sec and tape punch speed is 20 char/sec. A digital display unit is utilized.

OUTPUT

Visual verication of input/output data (response) is possible at the supervisory station.

Input error data rejection is signalled immediately at the supervisory station.

Automatic checking and data verification controls are built into the system.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Prices of this special purpose system are based on customer requirements and are established by negotiation.

System is installed and is maintained by the manufacturer on a service contract basis.

B. F. Goodrich Company, Footwear and Flooring Division

Approximate cost of basic system was $300,000.

PERSONNEL REQUIREMENTS

B. F. Goodrich Company, Footwear and Flooring Division

Daily Operation	One 8-Hour Shift
Engineers	1
Technicians & Operators	3

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System is installed, operating, and in use. It is operated for 8 hours/day on line and 2 hours/day off line, on a 5 day/week basis.

ADDITIONAL FEATURES AND REMARKS

Special purpose system.

System is operated partially on an on-line basis.

System has combined on-line and off-line operating features.

The supervisory station permits stock status reports to be obtained, utilizing "tailored" functional input/output devices for completing transactions.

B. F. Goodrich Company, Footwear and Flooring Division

This piece of equipment is of a special purpose nature designed specifically in answer to our finished goods footwear problem. Its outstanding feature is random access to any one of many thousands of separate items of either inventory or sales. An additional feature is the display of inventory or orders on a digital display console, one item at a time.

FUTURE PLANS

B. F. Goodrich Company, Footwear and Flooring Division

The future expansion of this system depends largely upon its current performance on the job for which it was built. Integration of our branch warehouse will be the next possible application.

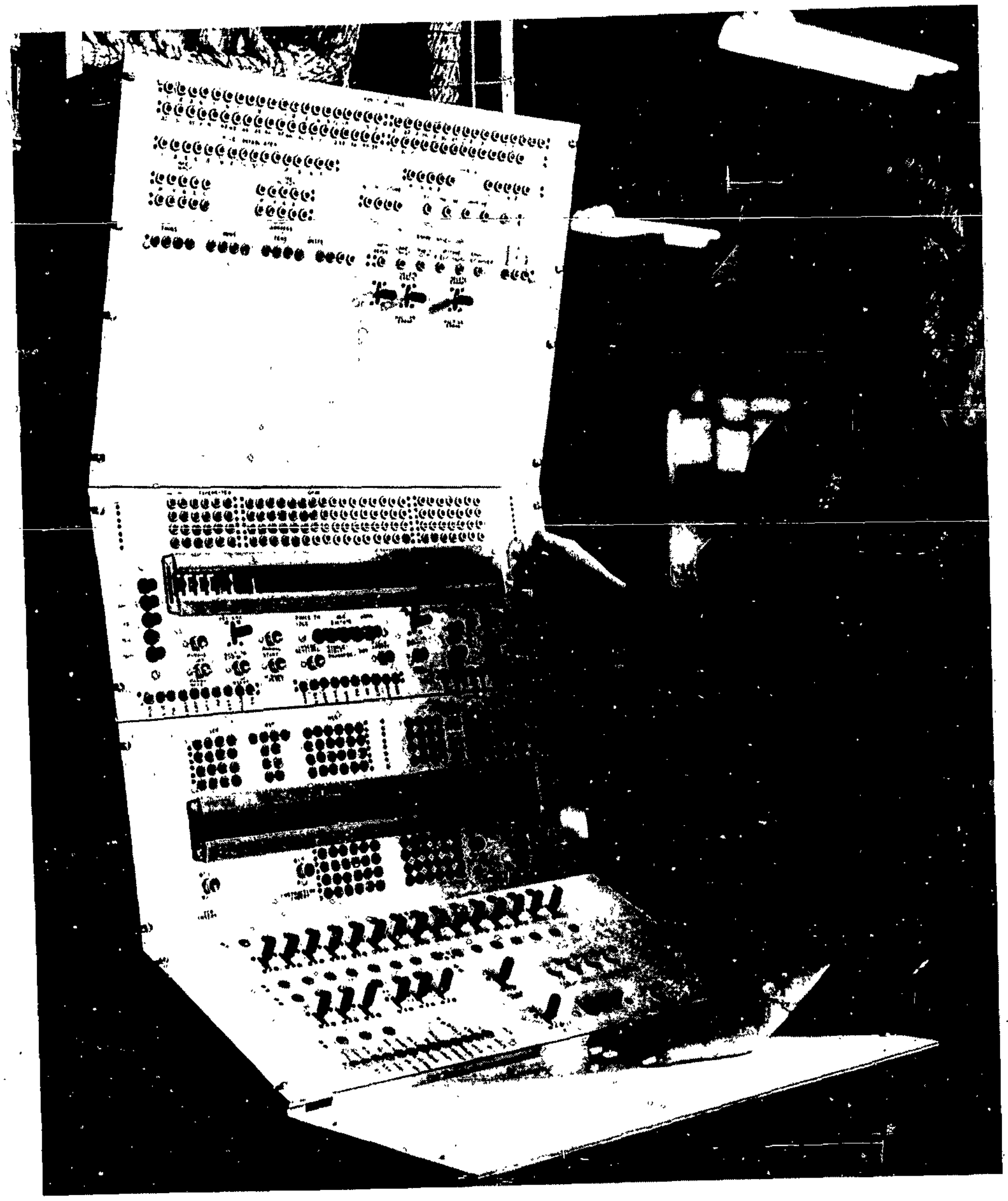
INSTALLATIONS

B. F. Goodrich Footwear and Flooring Company
Division of the B. F. Goodrich Company
Watertown 72, Massachusetts

TELEREGISTER TELEFILE MANUFACTURER

Teleregister Telefile Data Processing System

The Teleregister Corporation



Control Console of Telefile Data Processor

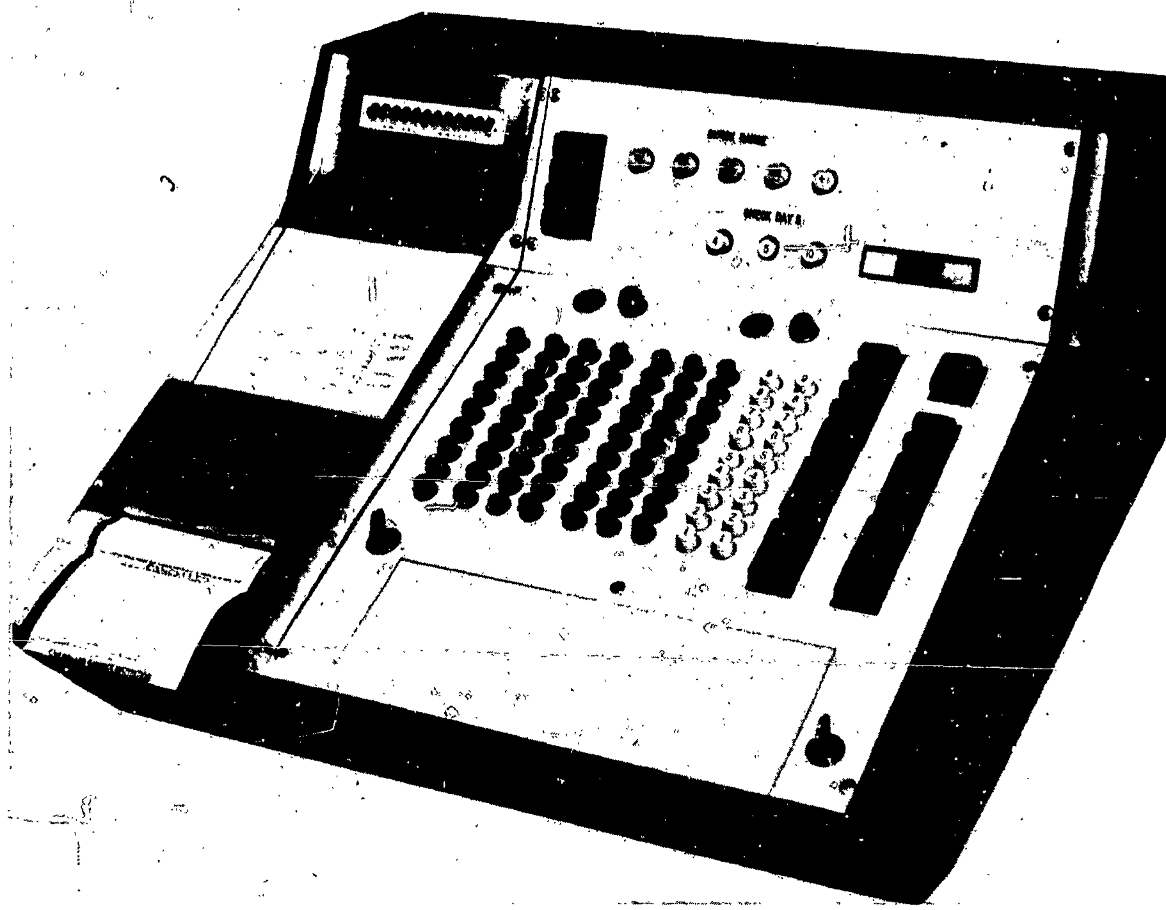
Photo by The Teleregister Corporation

APPLICATIONS

Manufacturer
System is performing the following applications:
Banking Systems - On line - Real Time
Airlines Reservations - On line - Real Time
Communications switching On-line Real Time
Off-line General Purpose Data Processing
Passenger Record Retrieval - Real Time

These systems are constructed to operate on-line with nation-wide data communications networks consisting of high speed (1000 bit/sec) and low speed (75 bit/sec) facilities. The switching, terminating and transceiver apparatus to equip these networks are provided by the manufacturer.

Society for Savings
Savings accounting and mortgage accounting.



Special Window Machine for Telefile On-line Savings Bank Accounting System

Photo by The Teleregister Corporation

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Decimal digits/word	one
Decimal digits/instruction	8
Instructions per word	Digit. Addressable
Instructions decoded	Over 200, depending on system
Arithmetic system	Fixed point

Variable length fields up to 100 digits.

Instruction type	One address

Sequential; first four digits can be considered an instruction

Number range	10^0 - 10^{99} absolute magnitude

Instruction word format

1 2	3 4	5 8
Order	Length of Field	Memory Address

Automatic built-in subroutines include Automatic Rerun in the event of certain failures and programmable separation of dual system.

Registers include the Accumulator Control (ACR), Memory Control (MCR), Instruction Control (ICR) and Quotient Control (QCR) registers.

All orders are performed by defining field lengths in the core memory. The addressable classification is digits. Instructions can be performed on from one to a hundred digits per operand.

ARITHMETIC UNIT

Operation Time	Including Storage Access Time Microseconds
Add	160 + 16 (No. of augend + addend digits)
Mult	80 + 16 (Sum of product digits)(3 x No. of Multiplier + Multiplicand digits)
Div	80 + 16 (Sum of quotient digits)(No. of digits in dividend)
	Excluding Storage Access Time Microseconds
Add	80 + 16 (No. of augend + addend digits)

Construction (Arithmetic unit only)

Unit consists of transistors, diodes and modular packages.

Arithmetic mode	Serial by digit, parallel by bit.
Timing	Synchronous
Operation	Sequential

Agent Set is Special Input-Output Device for use with the Telefile On-line Reservations System for United Airlines

Photo by The Teleregister Corporation

STORAGE

Media	Dec Digits	Access Microsec
Magnetic Cores	15,000	16
Magnetic Drums	1,050,000/drum	17,000
Discs	15,000,000/assembly	100,000

Magnetic Tape

No. of units that can be connected	54	Units
No. of chars/linear inch of tape	200	Chars/inch
Channels or tracks on the tape	6	Tracks/tape
Blank tape separating each record	1/2	Inches
Tape speed	150	Inches/sec
Transfer rate	12,000	Chars/sec
Start time	5	Millisec
Stop time	5	Millisec
Average time for experienced operator to change reel of tape	15	Seconds

Physical properties of tape

Width	1/2 Inches
Length of reel	2,400 Feet
Composition	Mylar sandwich

INPUT OUTPUT

Teleregister systems are primarily on-line rapid access business computing systems. Up to 29 sub-systems can be connected to any single main frame.

The system can consist of any number of processors each acting independently or with any two processors corss checking each other. The systems have been designed to accommodate any conventional input-output media.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	15,500
Transistors	3,500
Magnetic Cores	50,000 - 75,000

Above applies to a single Central Data Processor (TELEFILE). Similar proportion of diodes and transistors applies to other sub-systems.

CHECKING FEATURES

System has parity checking in and out of the core memory and in and out of any subsystem. Duality corss checks are available between processors and/or drums. Checks may also be programmed.

COST, PRICE AND RENTAL RATES

Prices are available on request. Teleregister has a full scale field-service operation in more than 100 cities in U. S., servicing all installations. This service organization has been in existence for 30 years.

PERSONNEL REQUIREMENTS

Personnel requirements vary with the complexity of any given system application.

Teleregister trains customer personnel at Stamford plant and provides on-site training as long as required.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Teleregister on-line systems have been operating with a record of 99.8% up-time since 1952. They employ duality and built-in controls to maintain this high degree of reliability, coupled with a rigid preventive maintenance program. They have proven on-line capability for 22 hour per day, 7 day per week service.

INSTALLATIONS

Society for Savings
31 Pratt Street
Hartford 1, Connecticut

The Howard Savings Institution
Newark 1, New Jersey

TELEREGISTER UNIFIED AIRLINE

Teleregister Unified Airline Processor

MANUFACTURER

The Teleregister Corporation

Typical Teleregister Unified Airline Data Processing Center

Photo by The Teleregister Corporation

APPLICATIONS

Special purpose, on-line, real-time wired program data processor, designed for inventory applications with a high volume of random, undisciplined, on-demand inquiries and transactions. Approximately 12,000 such transactions can be processed in one hour.

The term "Unified" stems from the unification of design requirements which enabled Teleregister to provide similar systems now in use by TWA, Western, National and Northeast Air Lines. These systems permit the airlines to process requests for reservations very quickly, and have measurably improved load factors and customer relations. A Unified system also handles hotel reservations for the Sheraton Corporation.

Forerunners of the Unified Systems were Teleregister's Magnetronic Reservisors which have been serving American Airlines since 1952, and a similar system used by Braniff International Airways since 1957. Pan American World Airways nd United Air Lines also use Teleregister systems, and United has ordered a new one (see TELEREGISTER TELEFILE) for installation in the next few months.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system Binary

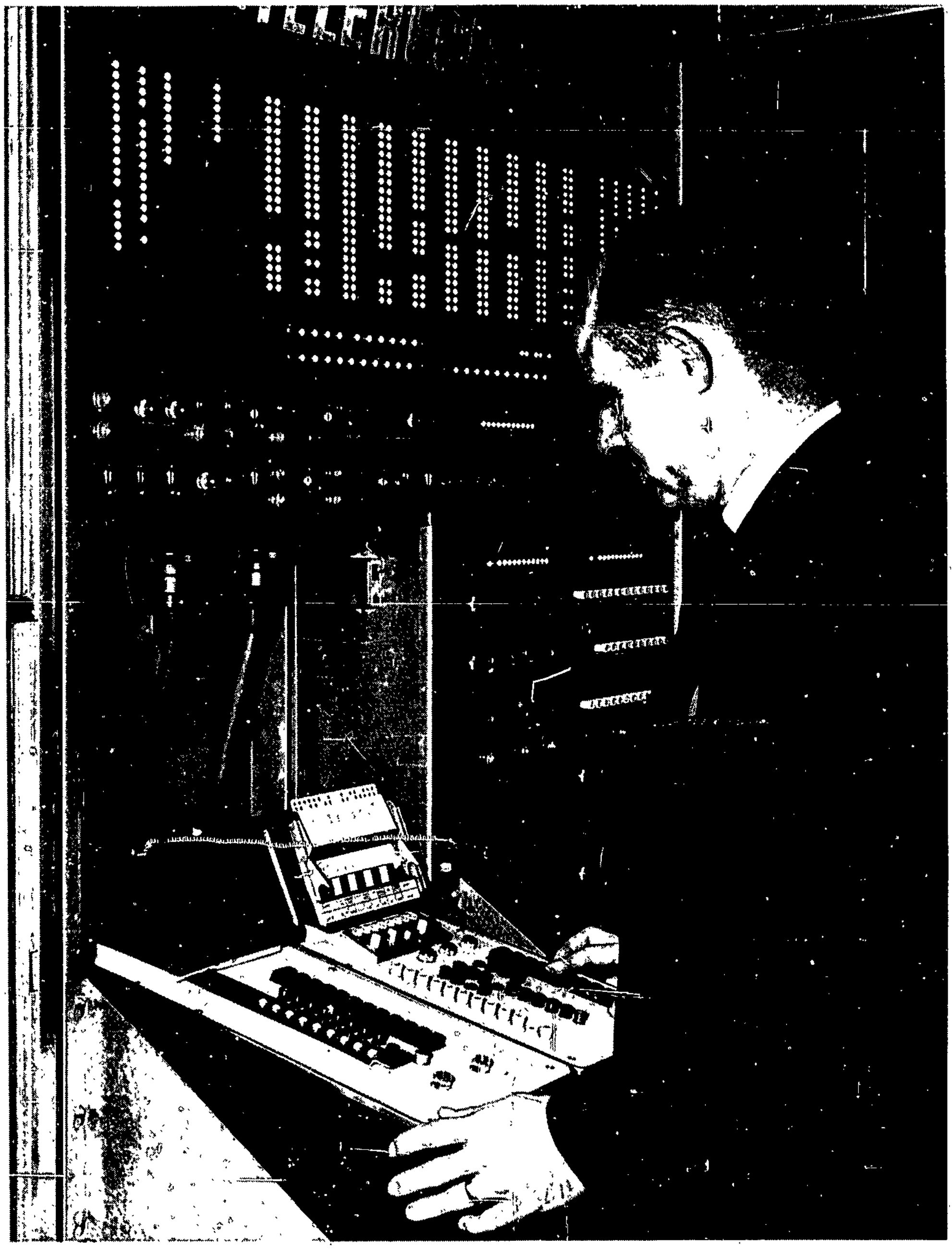
All logic and programs are wired into the processors by Teleregister. Additional programs and changes in logic are made by the manufacturer on a charge basis at the customer's request.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	17,010	10

Construction (Arithmetic unit only)
Vacuum-tubes and relays

Arithmetic mode Parallel



Supervisor's console of the TWA Teleregister data processor in the West Side Airlines Terminal, New York. TWA has three of the Teleregister Unified systems with data processors at New York, Chicago and Los Angeles

Photo by The Teleregister Corporation

Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Binary Digits/Drum	Access Microsec
Magnetic Drums	1,300,000	17,000

Teleregister Distant Central Office Transceiver (DCOT) at West Side Airlines Terminal is the automatic data message director through which all agent set traffic is channeled to and from the TWA Unified data processor at New York

Photo by The Teleregister Corporation

INPUT

Media	
Keysets	Parallel input
Punched Tape	200 words/min
Teletype	200 words/min

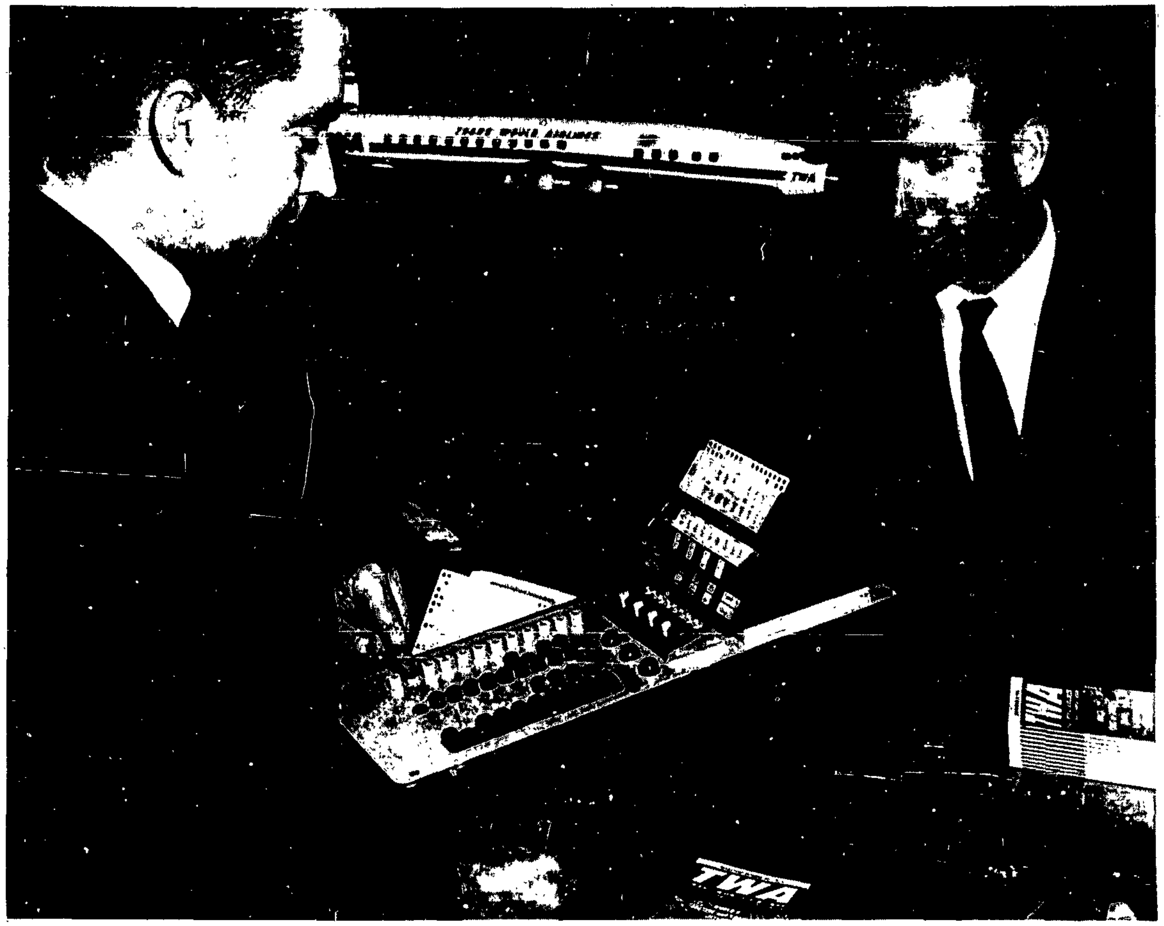
OUTPUT

Media	
Keysets	Parallel output
Punched Tape	200 words/min
Teletype	200 words/min
Printer	100 words/min

The principal input/output device used with the Teleregister Unified Airline Processor is the special purpose agent's keyset. To make an inquiry or initiate an inventory transaction, the agent selects and inserts a patented code plate in a slot in the agent set. The plate lists a total of 64 flights or segments thereof, but only a single row listing eight flights is visible at the time. On an availability inquiry the processor reply causes a display on the agent set by eight lamps associated with the eight flights listed on the code plate. Four conditions can be shown for each flight, such as lamp on - "open for sale", lamp out - "flight closed", fast flash - "wait list open", and slow flash - "special, check further". Keys on the agent set are used to designate month, date, and number of persons in the party, and one of ten command keys is used to initiate the call. Besides availability inquiries and sell and cancel transactions, the command keys include requests for departing a arriving flight information and the print out at the processor location of wait list requests.

There are approximately 800 keysets of the unified type, shown in the photograph, in use. They are compatible with the 600 keysets of the earlier "Reservisor" type.

Human engineering principles contributed to the design to give accuracy and speed in use. The code



TWA ticket agent using a Teleregister agent set to check availability for customer. Over 1000 similar agent sets are in operation for 8 major airlines.

Photo by The Teleregister Corporation

plate eliminates the keying in of flight numbers and gives a positive reference for all replies. The set is rugged and compact.

The processors include a teletype message editor, which scans incoming messages for data on seats sold or canceled. When the editor finds a transaction affecting inventory, it bids for the processor and passes on the data so that inventory is updated.

Similarly, when variable inventory control levels are reached, teletype status messages are automatically generated and transmitted to the interested stations.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	4,500
Diodes	3,000

Quantities dual processors and teletype translator at central location.

CHECKING FEATURES

Checking features include checks on magnetic drum recording and checks input data codes. Read back check on translation is optional. Also two processors are supplied with each system. They operate in "dual" mode, meaning that they operate simultaneously on the same problem, and cross check each other.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Volume, System	6,400 cu ft
Area, System	800 sq ft
Room size	1,000 sq ft including benches and cabinets
Floor loading	75 lbs/sq ft

Figures are for central equipment, including two processors and typical communications equipment.

All interconnections between processor units are made through overhead ducts. A false ceiling may be used if desired.

Air conditioner is supplied by customer.

PRODUCTION RECORD

Number produced to date	12
Number in current operation	12
Anticipated production rates	Two per year
Time required for delivery	18 months

COST, PRICE AND RENTAL RATES

Price varies with the number of modules required by the application. Attended maintenance for one, two, or three shifts is included in the service contract.

PERSONNEL REQUIREMENTS

One programmer is required.

Training made available by the manufacturer to the user includes training of an initial group in the operation of the agents key set and in the entering of basic data into the processor.

The logic and programs are wired in, therefore the only personnel required for operation, besides the reservation agents, is some one to assign inventory locations to flights and to enter the data that varies with schedule changes.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System up-time has averaged 99.8%. This degree of reliability, necessary for a on-line, on demand system, is achieved by using dual processors. In the event of an error detected by cross-checking between processors, a test routine is initiated, and if one of the processors is faulty, it is cut out and the other processor carries the load until repair has been accomplished. Many components, such as seekers and communications terminating equipment, are furnished in duplicate for fallback.

ADDITIONAL FEATURES AND REMARKS

The outstanding feature of the Unified Airline Processor is its ability to handle inputs from several hundred remote devices on a random demand basis. Since it is a real-time system, it makes accessible to hundreds of agents current information on seats available, returning cancelled space to inventory immediately.

Reports on inventory, seats sold, status of flights, etc. can be printed out.

A Unified Airline Data Processing System almost always includes communications equipment so that input/output sets may be located at any distance from the central equipment. Agent sets for Teleregister airline systems are located in more than 100 cities in the United States and Canada. For the Unified System, 75 or 100 words per minute telegraph circuits, leased by the customer, are used. Several drops can be located on one circuit through a speedy roll-call feature. Vertical parity checking is used to detect communication errors.

TRICE

Packard Bell Transistorized Real Time Incremental Computer Expandable

MANUFACTURER

Packard Bell Computer Corporation

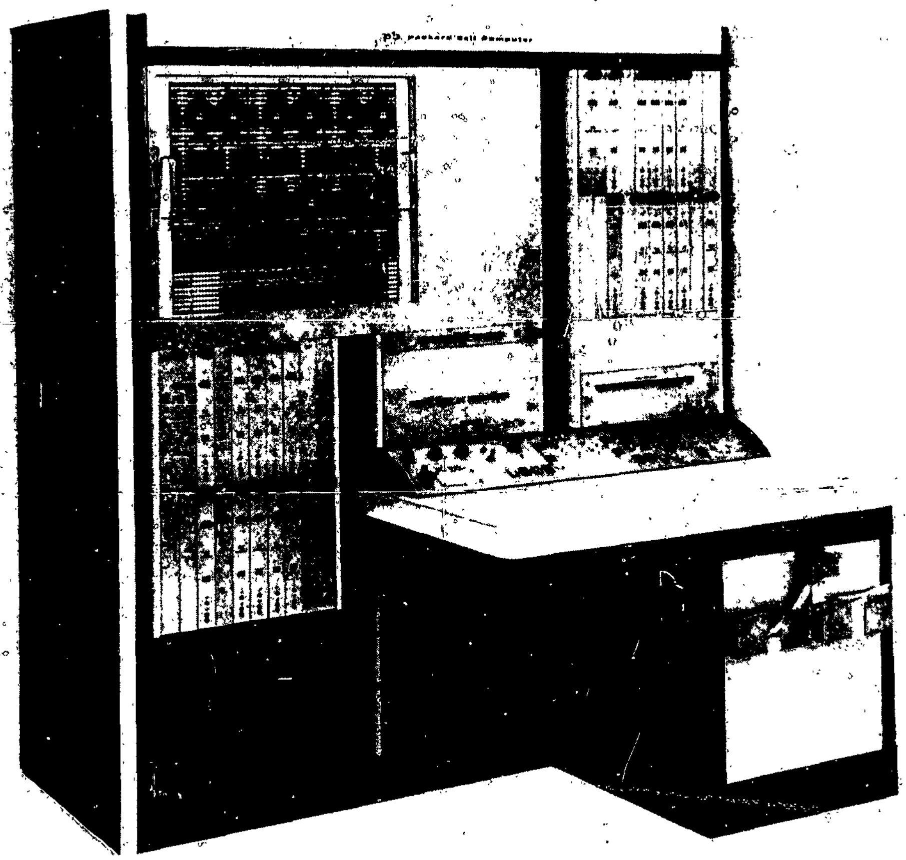


Photo by Packard Bell Computer Corporation

APPLICATIONS

The TRICE is a digital differential analyzer capable of solving directly any equations capable of being expressed in differential form at real time speeds. The TRICE may operate independently in the solution of these equations or it may be used with actual hardware or analog computers to perform real time simulation or test. The standard console can be supplied with up to 108 computing modules. Connection to additional consoles is provided for.

The TRICE consists of independent computing modules which perform the operation of integration, summation and multiplication. These modules are interconnected by means of a removable patch panel to solve differential equations. The TRICE achieves real time speeds by means of a 3 Mc clock frequency and parallel organization. All computing elements operate simultaneously. The iteration rate of the TRICE is 100 KC. This is 1,000 times faster than any previous DDA.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	26 bits plus sign max.
Arithmetic system	Fixed point

Incremental, ternary transfer (existence and sign)

Programmed interconnection of independent computing modules

The TRICE has the following types of independent computing modules:

Integrator	Δ Y Summer
Constant Multiplier	Servo
Variable Multiplier	Decision Servo

The TRICE is programmed much the same as an analog computer. The computing modules are connected directly to perform the operations indicated in the equations. This provides a "feel" for the problem and permits very rapid programming. The results of

a change in a problem parameter by the operator can be observed immediately in the form of X-Y plots, time history recordings, or digital readout. Thus the TRICE can be used as a design tool.

ARITHMETIC UNIT

Up to 100,000 iterations per second for all operations, including addition, multiplication and division.

An integrator uses 110 transistors.

Arithmetic mode	Serial	Incremental, ternary transfer
Timing	Synchronous	
Operation	Sequential and concurrent	

Integration can be performed with respect to any variable. The TRICE is not limited to integration with respect to time.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Delay Line (Electromagnetic)	1 word/module	26 bits + sign	10

A patch panel is used for "storage" of the program.

INPUT

Media	Speed
Keyboard	Manual

Either octal or decimal entry is possible.

Paper Tape	60 char/sec

A 108 module machine can be loaded in 30 sec.

A to D Converters	Incremental up to 100 KC

Packard Bell Model M-1 standard equipment. Voltage input is from transducers, etc.

OUTPUT

Media	Speed
Registers (Octal or Decimal)	Updated at 100 KC rate

Visual readout of digital information in computing registers

Paper Tape	60 char/sec

Automatic on time basis or at maxima or minima, etc.

D/A Converters	Incremental up to 100 KC

Voltage output to X-Y plotters, servo inputs, etc. PB Model DA-3 standard

The TRICE has a Decimal to Binary - Binary to Decimal converter Scaler which converts to binary and automatically scales decimal information for entry into the machine. The same converter also converts the binary information to decimal for output. An off line automatic typewriter is used to prepare and read the paper tape. Tape can also be prepared from the control panel keyboard.

Any number of analog input and outputs may be handled, through A to D and D to A converters. These inputs and outputs may be from hardware under test or an analog computer.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	1/module
Diodes	400/module
Transistors	110/module

Above figures are approximate.

The tubes are Amperex indicators for overflow indication. These are the only tubes used in the machine. They are miniature CRT's used for register and overflow indicators.

The TRICE is constructed entirely of solid-state components. The TRICE has been in existence for over two years to date, and has proven to be extremely reliable with very little down time. Low power consumption and freedom from heating problems provide a long operating life. All components are derated by at least 50%.

CHECKING FEATURES

Checking features include automatic halt on overflow. Overflow indicator provided for each module. Digital operation permits a digit-by-digit check against previous runs or against check solutions run of a general purpose computer.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

KVA, computer	1 to 2 KVA
Volume, computer	70 to 108 cu ft
Area, computer	19 to 27 sq ft

PRODUCTION RECORD

Number produced to date	5
Number in current operation	4
Number in current production	1
Number on order	1
Anticipated production rates	3/year
Time required for delivery	6 Months

COST, PRICE AND RENTAL RATES

	Approximate Cost of Component
Console (Control Unit & Patch Bay)	$ 23,000
Integrator (Max. of 65/console)	2,800 ea
Decision Servo (Max. of 12/console)	2,500 ea
Constant Multipliers (Max. of 30/console)	2,000 ea
Variable Multipliers (Max. of 6/console)	4,000 ea
Delta Y Summers 4 each	2,500 ea

Additional Equipment	Cost of Equipment
Paper Tape Input	$ 8,000
Paper Tape Output	6,000
Binary Decimal Converter & Scales	10,000
A-D Converters (M-1)	10,000
1 DA-3 in M-1 case	2,500
3 DA-3 in separate case	10,500

PERSONNEL REQUIREMENTS

One operator is required for each 8-hour shift.

Formal training is not required. After reading the programming manual several hours of familiarization with the machine enables anyone with a knowledge of differential equations to program and operate the machine.

ADDITIONAL FEATURES AND REMARKS

A 3 Mc clock plus parallel organization of independent computing modules provide computation at real time speeds formerly ascribed to analog computers but with an order of magnitude greater accuracy and exact repeatability.

Any number of analog channels in and out may be connected to operate with hardware or analog computers at an effective sampling rate of 100 KC/channel.

A Digital/Analog Function Table (DAFT), a digital system for the generation of arbitrary or analytical functions for analog and digital computers, is available. The DAFT is incremental and completely compatible with the TRICE.

UDEC I II III

Unitized Digital Electronic Calculator Models I II and III

MANUFACTURER

The Burroughs Corporation
Electronic Instrument Division

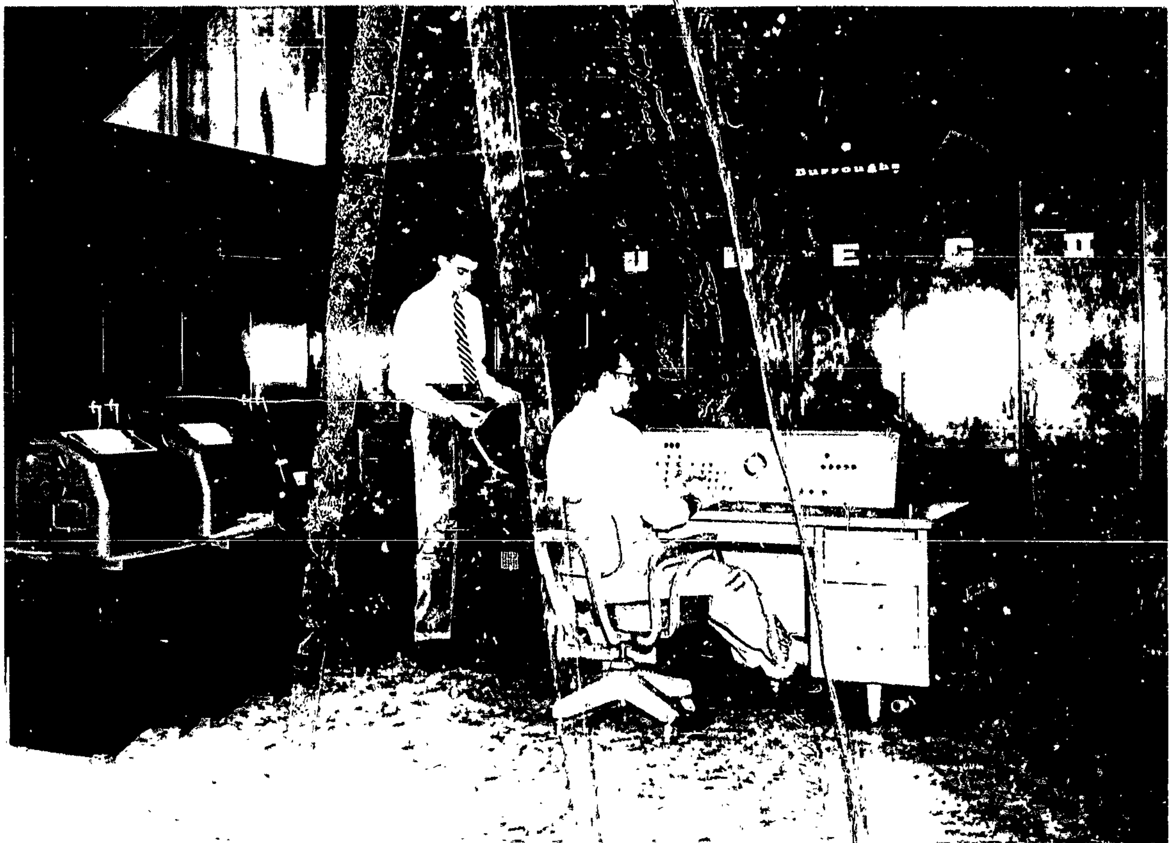


Photo by Burroughs Corporation

APPLICATIONS

Scientific computing and commercial data processing

PROGRAMMING AND NUMERICAL SYSTEM

UDEC I

Internal number system	Binary coded decimal
Decimal digits/word	10
Decimal digits/instruction	5
Instructions per word	2
Instructions decoded	34
Instructions used	34
Arithmetic system	Fixed point
Instruction type	One or two address
Number range	$10^{-9} \leq n \leq 10^{9}$

Program selection permits one- or two-address modes of operation. The decimal point may be manually set at any desired location. Two address operation is optional for optimum programming.

UDEC II III

Internal number system	Excess-three bin coded dec
Decimal digits/word	9 plus sign digit
Decimal digits/instruction	5
Instructions per word	2
Instructions decoded	40
Instructions used	32
Arithmetic system	Fixed point
Instruction type	One address
Number range	Movable decimal point

Two address word possible if second instruction in each word is unconditional transfer. Each instruction is one half word, i.e. 5 digits. Of these, 3 digits specify address and 2 digits the command.

ARITHMETIC UNIT

UDEC I

	Incl Stor Access Micr sec	Exclud Stor Access Microsec
Add time	176-264	88-176
Mult time	4,000	3,912 (avg)
Div time	6,000	5,912 (avg)

Construction

Vacuum tubes	3,000
Magnetic cores	320

Rapid access word registers	2
Basic pulse repetition rate	125 Kc/sec
Arithmetic mode	Serial-parallel
Timing	Synchronous

UDEC II III

	Exclud Stor Access Microsec
Add time	680
Mult time	30,000
Div time	30,000

Construction	Vacuum tubes
Basic pulse repetition rate	125 Kc/sec
Arithmetic mode	Serio parallel
Timing	Synchronous
Operation	Sequential

STORAGE

UDEC I

Media	Words	Digits	Access Microsec
Magnetic Drum	5,300	53,000	8,000(avg)
Magnetic Cores	100	1,000	88
UDEC II III			
Magnetic Core	1,000		20/5 digits
Magnetic Drum	10,000		8,500(avg)

53,000 decimal digits total drum storage. Drum information contained in blocks of 200 words for transfer to and from core storage.

INPUT

UDEC I

Media	Speed
Paper Tape (Ferranti Photoelectric)	400 char/sec
Keyboard	Manual
UDEC II III	
Paper Tape (Ferranti Photoelectric)	120 char/sec

Paper Tape (Potter magnetic tape handler modified for photoelectric input) Magnetic Tape (Potter)

OUTPUT

UDEC I

Media	Speed
Printer	6 char/sec
Paper Tape	60 char/sec
UDEC II III	
Paper Tape (Teletype) (2)	(5-level) 60 char/sec
Paper Tape (Teletype)	(7-level) 60 char/sec
Magnetic Tape (Potter)	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

UDEC I

Tubes	3,000
Tube types	8
Crystal diodes	6,000
Magnetic cores	4,700
Separate cabinets	28 standard, 19 in x 7-ft, ea.

Tube types include 6CL6, 5687, 7AK7, 6197, 12AU7, 12AT7, 6BC5, 12BH7.

System is constructed of standard Burroughs pulse control equipment and interconnected with R662U coaxial cable.

UDEC II III

Tubes 3,000

Machine consists of Burroughs Pulse Control Equipment, approximately 600 units in all.

CHECKING FEATURES

UDEC I

Modulo 3 arithmetic check

Modulo 3 check on each word transferred to and from storage.

Forbidden combination multiply and divide check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

UDEC I

Power, computer	30 Kw 32 KVA
Space, computer	400 sq ft area, floor space part of machine
Capacity, air condit	Blower-exhaust type

System arranged in form of an almost closed rectangle.

UDEC II III

Power, computer	33 Kw
Space, computer	31 racks
Capacity, air cond.	15 Tons

PRODUCTION RECORD

Number produced	2 (Incl UDEC I)
Number in current operation	2
Delivery time	6 months

UDEC I located at Wayne University, Detroit, Michigan.

UDEC II III located at Burroughs Corporation, Philadelphia, Pennsylvania.

COST, PRICE AND RENTAL RATES

UDEC I

Approximate cost of basic system $500,000.

Approximate cost of modifications and additions $200,000.

UDEC II III

Approximate cost of basic system	$200,000.
Additional equipment	100,000.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

UDEC I

Average error-free running period	7 Hours/8 Hour/shift
Good time	8.5 Hours
Attempted to run time	10 Hours
Operating ratio (Good/Attempted to run time)	0.85
Figures based on period	May 53 to Nov 56.
Passed Customer Acceptance Test	Dec 53.

Decimal-binary automatic conversion is utilized.

UDEC II III

Average error-free running period	6 Hours
Operating ratio	0.85
Passed Customer Acceptance Test	Oct 53

ADDITIONAL FEATURES AND REMARKS

UDEC II III

Burroughs UDEC III is a general modification of UDEC II. UDEC III will consist of Burroughs pulse control equipment which has been used in UDEC II. The basic flexibility of this equipment provides for a maximum of modification with respect to special instructions and special input-output equipment which must be added as required.

INSTALLATIONS

Wayne University (UDEC I)
Computational Laboratory
Detroit 1, Michigan

Burroughs Corporation (UDEC II III)
Electronic Instrument Division
1209 Vine Street
Philadelphia, Pennsylvania

UNIVAC 60

Universal Automatic Computer Model 60

MANUFACTURER

Remington Rand Univac Division
Sperry Rand Corporation

APPLICATIONS

Manufacturer
Business and scientific data processing.

Joliet Arsenal, Comptroller, E.A.M. Systems Branch Located at Joliet Arsenal, Joliet, Illinois, the system is used for civilian payroll, civilian personnel statistics, stock accounting, cost accounting, and procurement accounting.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Biquinary, decimal, and alphabetic
Decimal digits/word	Variable from 1 to 10 digits plus sign
Digits/instruction	Not internally programmed
Arithmetic system	Fixed point, variable
Instruction type	Three address
Number range	Variable

ARITHMETIC UNIT

The timing is synchronous.

The operation is sequential.

One full cycle on the computer requires 400 milliseconds. 75 milliseconds are required for feeding, sensing, and punching the card. 325 remain for calculation. If the calculation requires more than 325 milliseconds, the computer automatically waits until the end of calculation signal has been given before punching, feeding and sensing the next card. Buffing is not used.

The purpose of the electronic computing unit is:
To connect card columns for sensing, punching, and reproducing.
To set constant values.
To set the machine for the operations to be performed and the sequence of the operations.
To perform all calculations with an electronic accumulator.
To store the values calculated.
To check each arithmetic step.
To visibly read all elements of all arithmetic steps.
The arithmetic unit uses floating point but storage uses a selected fixed point.
The biquinary code is as follows:

Digits	Biquinary Code
0	0
1	1,0
2	2
3	1,2
4	4
5	1,4
6	6
7	1,6
8	8
9	1,8

Alphabetic characters are wired to become two or three numeric characters at the input level. For example, an A becomes 111, a C becomes 99. See Storage.

Negative numbers are carried as the tens complement of the number. A negative sign indicates that the value is negative instead of positive.

The location of the decimal point is variable and may be arbitrarily assigned to each input and storage location.

There is only one arithmetic register, called the accumulator. It has a capacity of 22 digits. The computation of each program step takes place within the accumulator. For example, an addition would be performed as follows:

1) Clear the accumulator
2) Enter the first value according to its decimal location.
3) Enter the decimal location of the second value.
4) Shift the first value to align with the decimal of the second value.
5) Enter the second value, performing the process of addition.
6) Enter the decimal location of the result storage and shift the result to align with it.
7) Place the result in the result storage.
8) Subtract value two from the result.
9) Subtract value one from the result of 8).
10) Check to be certain that the accumulator is zero.

Each step is balanced to zero before the computer continues to the next step. The four possible steps and the method used to check each are:

Step	Proof
Value 1 + Value 2 = Result	Result - Value 2 - Value 1 = 0
Value 1 - Value 2 = Result	Result + Value 2 - Value 1 = 0
Value 1 x Value 2 = Result	Result/Value 2 - Value 1 = 0
Value 1/Value 2 = Result	Result x Value 2 - Value 1 = 0

The computer will not continue unless the step checks to zero.

The computer has automatic decimal alignment. Programs have been developed which use a floating point method, although the computer is operating with automatic alignment.

Scaling may be accomplished by multiplying or dividing the number by a factor, or changing the decimal location by a selector.

An overflow stops the computer.

The remainder is dropped off in the final result, although it is used during the proof of the step.

The round-off of sums, differences, products and quotients depends on the decimal location of the result storage. The accumulator unit has 22 positions, as follows:

M Sections
1 2 3 4 5 6 7 8 9 10 11

A Sections
11 10 9 8 7 6 5 4 3 2 1

All results are placed in storage from positions 10-1 of the A Section. Each storage is assigned a decimal location for the program involved. A loca-

tion of 4/3 would mean that three places are to be retained in the result following the decimal. If the result of any step-addition, subtraction, multiplication, or division contains more places than those allowed in the result storage, the additional digits will be located in the M Section, beginning in column 11. When the result is placed in the storage unit, they are thereby rounded off. Rounding off requires an addition step.

Comparisons are made by two subtraction steps. Each step has two branchings, plus and minus. Zero is always considered plus. The first step of the two value 1 minus value 2. If the result is minus, value 2 is greater than value 1. If the result is plus, value 1 is equal to or greater than value 2. The second step would be value 2 minus value 1. If the result is minus, value 1 is greater than value 2. If the result is plus, value 1 and value 2 are equal.

Control Unit

The computer has no stored program.

The input-output panel indicates the card fields to be sensed, punched and reproduced. The constant program panel indicates the program to be followed, step by step, and the constant value which will be used.

The computer operates on a three address system. Each program step, which is externally wired, contains the following six instructions, in the following form:

V1 Pr V2 = R - BR + BR

- V1 The storage, constant, or card-read field to be used as value 1.
- Pr The process (+, -, x, /)
- V2 The storage, constant, or card-read field to be used as value 2.
- R The storage into which the result is to be placed.
- -BR The next step or operational function to be performed if the sign of the result is minus.
- +BR The next step or operational function to be performed if the sign of the result is plus.

Breakpoint stops may be included in the program. At the plus or minus branching of any step an instruction requiring a division of 0 by 0 or a number by 0 may be given. Both of these steps cause the computer to stop, and a corresponding light is lit.

The electronic computing unit contains a control panel with a dial. Each step may be dialed in turn. For each step value 1, value 2, the result, the process, the branching, all decimal locations and whether the step checks may be read from the panel.

The computer will stop under the following conditions:

1) Empty feeding magazine.
2) Full receiving magazine or chip pan.
3) Sensing of alpha.
4) Zero divided by zero.
5) Number divided by zero.
6) Incorrect voltage.
7) Temperature too high.
8) Overflow condition on a step.
9) Failure to check.

STORAGE

Medium	Words	Digits
Vacuum tube	6	60

The storage system used is biquinary. Each column of storage contains 5 tubes, representing the digits 1, 3, 5, 7, and 9. There is no tube for zero, which is represented by the fact that none of the tubes are lit. An odd digit is represented by the corresponding tube 1, 3, 5, 7, or 9. An even digit is represented by the odd digit which is immediately lower in value, plus the 9. Therefore, a 2 is 1 plus 9, a 4 is 3 plus 9, a 6 is 5 plus 9 and an 8 is 7 plus 9.

The word length in storage is ten digits (columns) plus sign.

Alphabetic characters require five columns of storage for two characters, three columns for a single character. A single word can therefore contain 4 columns of alphabetic characters as opposed to 10 columns of numeric characters.

Storage is actually part of the computing unit. There is no buffing unit.

INPUT

Medium

Card Sensing-Punching Unit

The purpose of the Card Sensing-Punching unit is to sense and punch tabulating cards and to indicate and control general machine operation.

A maximum of 36 words (card read fields) may be used in one program. Up to 60 digits may be divided as necessary among 36 words. The sign of each field is in addition to the 60 digits.

A 90 column punched card code is used. This is the same biquinary code as is used in the storage unit. All 36 words are sensed simultaneously on one cycle. Five columns are required to sense two columns of alphabetic information; three columns are required to sense one column of alphabetic information.

Joliet Arsenal

Medium	Speed
Cards	150 cards/min

OUTPUT

Medium

Card Sensing-Punching Unit

Joliet Arsenal

Medium	Speed
Cards	150 cards/min

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Card Sensing-Punching Unit

The Card Sensing-Punching Unit measures 2 ft. 11 in. long, 2 ft. 6 in. wide, 5 ft. 9 in. high, and weighs 1,020 lbs. This unit may operate from any of the following power services:

a) 208 volt single phase, 4 wire, 60 cycles
b) 230 volt single phase, 3 wire, 60 cycles
c) 220 volt single phase, 3 wire, 60 cycles
d) 120 volt three phase, 4 wire, 60 cycles
e) 220 volt three phase, 3 wire, 60 cycles
f) 220 volt three phase wye system, 50 cycles.

The Electronic Computing Unit measures 7 ft. 2 in. wide, 2 ft. 6 in. deep, 5 ft. 9 in, high and weighs 2,210 lbs.

The unit operates from the same power sources as the Card Sensing-Punching Unit.

The unit is ventilated by fan forced room air.

Joliet Arsenal

Power, air conditioner	5 Kw	0.90 pf
Volume, computer	145 cu ft	
Volume, air conditioner	31.5 cu ft	
Area, computer	43 sq ft	
Area, air conditioner	4.75 sq ft	
Room size	16 ft x 10 ft 6 in	
Floor loading	80 lbs/sq ft	
Weight, computer	3,230 lbs	
Weight, air conditioner	500 lbs	

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $75,000.

Rental rate for basic system, standard shift $690-$1,050/month.

Second shift operation charge is an additional 50% of the Standard Rate.

Third shift operation charge is an additional 50% of the Standard Rate.

Maintenance, including cost of parts, except due to customer negligence, is included in the rental rates above.

The charge for maintenance to a customer who purchases, rather than leases, but who requires maintenance operations is $3,750 per year for a machine less than 6 years old and $4,500 for a machine 6 to 11 years old.

Customer's personnel are trained at no extra charge.

Joliet Arsenal

Basic system rents at $740.

4 Key punches, 3 tabulators, 1 auto-verifier, 3 summary punches, 1 collator, 2 interpreters, 1 reproducer, and 3 sorters rents at $2,594/month.

PERSONNEL REQUIREMENTS

Joliet Arsenal

	One 8-Hour Shift
Supervisors	3
Programmers	2
Clerks	1
Operators	11

Operation tends toward open shop.

Methods of training used includes formal training furnished by the manufacturer and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Joliet Arsenal

Good time	15 Hours/Week (Average)
Attempted to run time	18 Hours/Week (Average)

Above figures based on period from Jun 59 to Jun 60

Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

The Univac 60 and Univac 120 Systems are similar, except with regard to such items as storage capacity, price, rental rate, and service costs.

FUTURE PLANS

Joliet Arsenal

Continuation of improvements and refinement of present applications.

INSTALLATIONS

Joliet Arsenal
Comptroller, E.A.M. Systems Branch
Joliet, Illinois

PRODUCTION RECORD

Total number of Univac 60 and 120 Systems 1,000

UNIVAC 120
Universal Automatic Computer Model 120

MANUFACTURER
Remington Rand Univac
Division of Sperry Rand Corporation

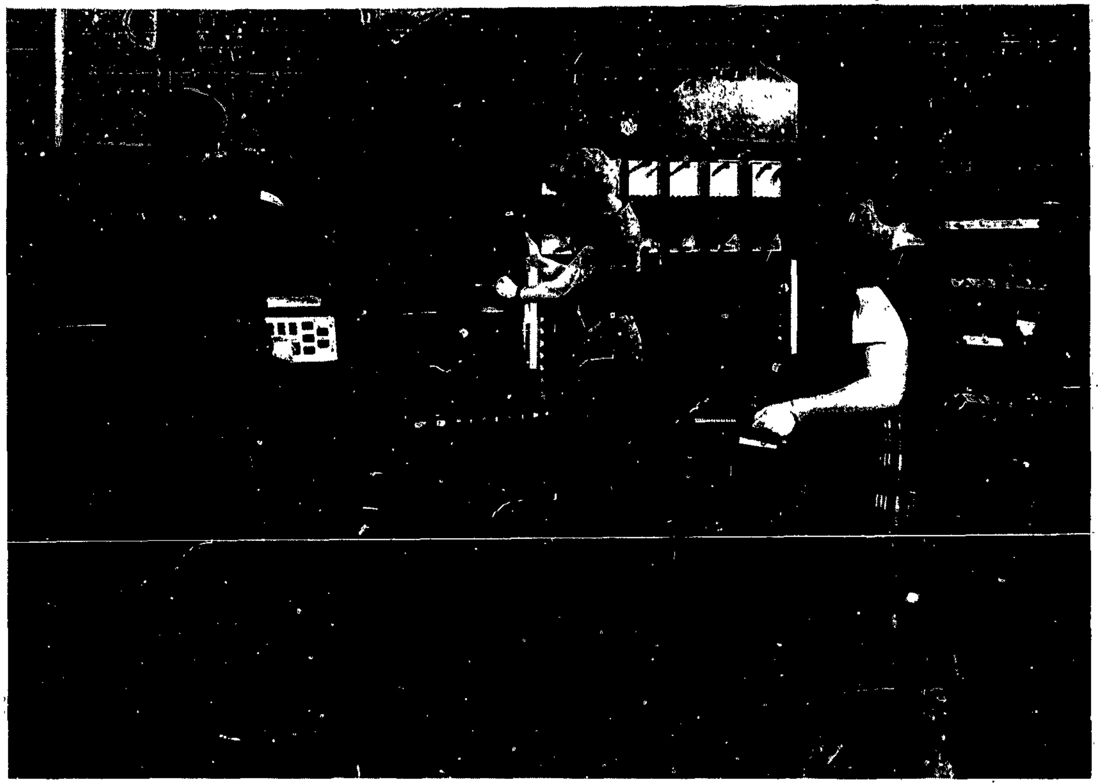


Photo by Department of Interior, Bureau of Mines

APPLICATIONS

Manufacturer
Business and scientific data processing.
U. S. Bureau of Reclamation
Located at Ephrata, Washington, system is used for the solution of engineering, e.g., earthwork and subdivision of sections, and administrative problems, e.g. irrigation accounts, crop census, land owership records, payroll, accounts receivable and payable, stock records, personnel roster, and vehicle utilization and costs.
U. S. Army Chemical Corps Proving Ground, Dugway
Located in the Computer Section, Test Design & Analysis Office, the system is used for calculation of results of various chemical and biological field tests, statistical and mathematical analysis of field test results, meteorological research, and cost accounting, payroll, property inventory, and other standard commercial type applications.
U. S. Bureau of Mines
Located at the Central Experiment Station, Bureau of Mines, Pittsburgh 13, Pennsylvania, the system is used in the Computation Laboratory. The Computation Laboratory is an internal service bureau whose facilities are made available to all organizational segments of the Bureau of Mines. These services can be divided into three major categories: technical, statistical and accounting. The technical calculations encompass many areas in the general field of numerical analysis such as determination of curves of best fit, rational approximations of a variety of functions, numerical integration and differentiation, matrix operations, interpolation and the solution of algebraic and transcendental equations. These calculations result from the desire for numerical solutions of some of the problems encountered by technical personnel in the Bureau's programs in combustion, explosive and mineral research, statistical services include those rendered to the film library and distributing group, Coal Analysis Section, and in basic data reduction and correlation studies for some of the Bureau's major canvasses. Accounting services include payroll and cost distribution, property inventory and transactions, and employee personnel records.
AiResearch Manufacturing Company of Arizona
Located at 402 South 36th Street, Phoenix, Arizona, the two systems are used for computation of payroll, earnings to date, accrual of vacation and sick leave hours and money, extension of labor charges and burden, production planning, production parts scheduling, parts issue, accounts payable, inventory accounting,

Photo by Department of Interior, Bureau of Reclamation

cost accounting, laboratory facility burden, quality control, and assets depreciation.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Biquinary, decimal, and alphabetic
Decimal digits/word	Variable from 1 to 10 digits plus sign
Number of digits/instruction	Not internally programmed
Arithmetic system	Fixed point, variable
Instruction type	Three address
Number range	Variable

ARITHMETIC UNIT

The timing is synchronous.
The operation is sequential.
One full cycle on the computer requires 400 milliseconds. 75 milliseconds are required for feeding, sensing, and punching the card. 325 remain for calculation. If the calculation requires more than 325 milliseconds, the computer automatically waits until the end of calculation signal has been given before punching, feeding and sensing the next card. Buffing is not used.

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To perform all calculations with an electronic accumulator.
To store the values calculated.
To check each arithmetic step.
To visibly read all elements of all arithmetic steps.
The arithmetic unit uses floating point but storage uses a selected fixed point.
The biquinary code is as follows:

Digits	Biquinary code
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3	1,2
4	4
5	1,4
6	6
7	1,6
8	8
9	1,8

Photo by U. S. Army Chemical Corps Proving Ground (Dugway)

Alphabetic characters are wired to become two or three numeric characters at the input level. For example, an A becomes 111, a C becomes 99. See Storage.

Negative numbers are carried as the tens complement of the number. A negative sign indicates that the value is negative instead of positive.

The location of the decimal point is variable and may be arbitrarily assigned to each input and storage location.

There is only one arithmetic register, called the accumulator. It has a capacity of 22 digits. The computation of each program step takes place within the accumulator. For example, an addition would be performed as follows:

1) Clear the accumulator.
2) Enter the first value according to its decimal location.
3) Enter the decimal location of the second value.
4) Shift the first value to align with the decimal of the second value.
5) Enter the second value, performing the process of addition.
6) Enter the decimal location of the result storage and shift the result to align with it.
7) Place the result in the result storage.
8) Subtract value two from the result.
9) Subtract value one from the result of 8).
10) Check to be certain that the accumulator is zero.

Each step is balanced to zero before the computer continues to the next step. The four possible steps and the method used to check each are:

Step	Proof
Value 1 + Value 2 = Result	Result - Value 2 - Value 1 = 0
Value 1 - Value 2 = Result	Result + Value 2 - Value 1 + 0
Value 1 x Value 2 = Result	Result ÷ Value 2 - Value 1 = 0
Value 1 ÷ Value 2 = Result	Result x Value 2 - Value 1 = 0

The computer will not continue unless the step checks to zero.

The computer has automatic decimal alignment. Programs have been developed which use a floating point method, although the computer is operating with automatic alignment.

Scaling may be accomplished by multiplying or dividing the number by a factor, or changing the decimal

location by a selector.
An overflow stops the computer.
The remainder is dropped off in the final result, although it is used during the proof of the step.
The round-off of sums, differences, products and quotients depends on the decimal location of the result storage. The accumulator unit has 22 positions, as follows:

M Sections

1 2 3 4 5 6 7 8 9 10 11

A Sections

11 10 9 8 7 6 5 4 3 2 1

All results are placed in storage from positions 10-1 of the A Section. Each storage is assigned a decimal location for the program involved. A location of 4/3 would mean that three places are to be retained in the result following the decimal. If the result of any step-addition, subtraction, multiplication, or division contains more places than those allowed in the result storage, the additional digits will be located in the M Section, beginning in column 11. When the result is placed in the storage unit, they are thereby rounded off. Rounding off requires an addition step.
Comparisons are made by two subtraction steps. Each step has two branchings, plus and minus. Zero is always considered plus. The first step of the two would be value 1 minus value 2. If the result is minus, value 2 is greater than value 1. If the result is plus, value 1 is equal to or greater than value 2. The second step would be value 2 minus value 1. If the result is minus, value 1 is greater than value 2. If the result is plus, value 1 and value 2 are equal.

Control Unit

The computer has no stored program.
The input-output panel indicates the card fields to be sensed, punched and reproduced. The constant program panel indicates the program to be followed, step by step, and the constant values which will be used.
The computer operates on a three address system. Each program step, which is externally wired, contains the following six instructions, in the following form:

V1 Pr V2 = R - Br. + Br.

V1	The storage, constant, or card-read field to be used as value 1.
Pr	The process (+, -, x, ÷)
V2	The storage, constant, or card-read field to be used as value 2.
R	The storage into which the result is to be placed.
-Br	The next step or operational function to be performed if the sign of the result is minus.
+Br	The next step or operational function to be performed if the sign of the result is plus.

Breakpoint stops may be included in the program. At the plus or minus branching of any step an instruction requiring a division of 0 by 0 or a number by 0 may be given. Both of these steps cause the computer to stop, and a corresponding light is lit.
The electronic computing unit contains a control panel with a dial. Each step may be dialed in turn. For each step value 1, value 2, the result, the process, the branching, all decimal locations and whether the step checks may be read from the panel.
The computer will stop under the following conditions:

1) Empty feeding magazine
2) Full receiving magazine or chip pan
3) Sensing of alpha
4) Zero divided by zero
5) Number divided by zero
6) Incorrect voltage
7) Temperature too high
8) Overflow condition on a step
9) Failure to check.

STORAGE

Manufacturer

Medium	Words
Vacuum Tube	12

The code system used is biquinary. Each column of storage contains 5 tubes, representing the digits 1, 3, 5, 7, and 9. There is no tube for zero, which is represented by the fact that none of the tubes are lit. An odd digit is represented by the corresponding tube 1, 3, 5, 7, and 9. An even digit is represented by the odd digit which is immediately lower in value, plus the 9. Therefore, a 2 is 1 plus 9, a 4 is 3 plus 9, a 6 is 5 plus 9 and an 8 is 7 plus 9.
The word length in storage is ten digits (columns) plus sign.
Alphabetic characters require five columns of storage for two characters, three columns for a single character. A single word can therefore contain 4 columns of alphabetic characters as opposed to 10 columns of numeric characters.
Storage is actually part of the computing unit. There is no buffing unit.

Bureau of Reclamation

Constant Storage 108 Digits
These digits may be grouped into as many as 36 elements or individual constant values from 1 to 10 digits.
Intermediate Storage 12 units of 10 columns each
Each unit related to accumulator columns 1 through 10.

INPUT

Manufacturer

Medium
Card Sensing-Punching Unit
The purpose of the Card Sensing-Punching Unit is to sense and punch tabulating cards and to indicate and control general machine operation.
A maximum of 36 words (card read fields) may be used in one program. Up to 120 digits may be divided as necessary among 36 words. The sign of each field is in addition to the 120 digits.
A 90 column punched card code is used. This is the same biquinary code as is used in the storage unit. All 36 words are sensed simultaneously on one cycle. Five columns are required to sense two columns of alphabetic information; three columns are required to sense one column of alphabetic information.

Bureau of Reclamation

Input Storage - 90 columns: one for each column of a 90 column card.
Input - 120 columns from the 90 columns of input storage. Speed is 125 cards/min.
The input is grouped into 12 identical units of 10 columns each. Each unit is related to accumulator columns 1 through 10.
These 120 columns of input will accommodate as many as 36 elements or individual input values varying in size from one to 10 digits.

Dugway P. G.

Medium	Speed
Cards	150 cards/min
AiResearch	
Cards	150 cards/min

OUTPUT

Manufacturer

Card Sensing-Punching Unit

The Card Sensing-Punching Unit measures 2 ft. 11 in. long, 2 ft. 6 in. wide, 5 ft. 9 in. high, and weighs 1,020 lbs. This unit may operate from any of the following power services:

a) 208 volt single phase, 4 wire, 60 cycles
b) 230 volt single phase, 3 wire, 60 cycles
c) 220 volt single phase, 3 wire, 60 cycles
d) 120 volt three phase, 4 wire, 60 cycles
e) 220 volt three phase, 3 wire, 60 cycles
f) 220 volt three phase wye system, 50 cycles

The Electronic Computing Unit measures 7 ft. 2 in. wide, 2 ft. 6 in. deep, 5 ft. 9 in. high and weighs 2,210 lbs.

The unit operates from the same power sources as the Card Sensing-Punching Unit.

The unit is ventilated by fan forced room air.

Bureau of Reclamation

Output Storage - 90 columns: one for each column of a 90 column card. Speed is 125 cards/min.

Output - 120 columns for the 90 columns of output storage. The output is from the twelve, 10 column Intermediate Storage Units, for the punching of the 10-digit maximum results.

Dugway P. G.

Medium	Speed
Cards	150 cards/min
AiResearch	
Cards	150 cards/min

This machine has only one card input/output device, therefore, the input and output cards are the same or must be interfiled prior to computing. The machine normally operates at the 150 cards/min speed, but does not have a post sensing station for verification. Two passes of the cards are required for verification.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Bureau of Reclamation

Power, computer	10 Kw	8.0 KVA
Volume, computer		142.5 cu ft
Area, computer		43 sq ft
Room size, computer		143 sq ft (working area)
		168 sq ft (rectangular area)
Floor loading		75.1 lbs/sq ft
Weight, computer		3,230 lbs

Site preparation: Installation of 220-volt power junction box, acoustical tile (ceiling of EDP room only) and ventilating hood for the Univac 120. The building is of reinforced concrete construction with the EDP unit located in the basement.

The Univac 120 may be adjusted at the time of installation to operate from 208, 220, or 230 volts, alternating current, providing the regulation of the power source can be held to plus or minus 5% of any of the above voltages. This voltage must be measured at the junction of the power supply line and computer power line, and under normal line load conditions. In the event the regulation is not within the 5%, plus or minus, a voltage regulator is necessary.

The air conditioner is included in the Electronic Computing Unit of the Univac 120 to assist in maintaining that unit at the most desirable operating temperature.

The air conditioner consists of four 15 inch fans in the base located above air filters. These fans operate at 1750 rpm to force air through the inside of the unit.

The heat dissipation is approximately 400 BTU/min. The air flow through the machine to affect cooling is 2500 cubic feet per minute.

Dugway P. G.

Power, computer	10.3 Kw	8 KVA	0.777 pf
Volume, computer	142.5 cu ft		
Volume, air conditioner	61.25 cu ft		
Area, computer	25 sq ft		
Area, air conditioner	8.75 sq ft		
Room size, computer	22 ft x 27 ft		
Room size, air conditioner	22 ft x 27 ft		
Floor loading	75 lbs/sq ft		
Capacity, air conditioner	3 Tons		
Weight, computer	3,230 lbs		
Weight, air conditioner	700 lbs		

The basic design of the building provided for a computer room and no special preparations were required.

Bureau of Mines

Power, computer	8 KVA 0.95 pf w/voltage regulator
Volume, computer	142.5 cu ft
Area, computer	43 sq ft
Room size, computer	145 sq ft min.
Floor loading	75.1 lbs/sq ft
	303.1 lbs concen max
Capacity, air conditioner	17 Tons
Weight, computer	3,230 lbs

Special voltage regulator and transformer required for efficient operation. Also, the 17 ton air conditioner cools the entire area.

AiResearch

Power, computer	8.3 KVA 208v at 38 amps
Volume, computer	517.5 cu ft
Area, computer	43 sq ft
Room size, computer	16 ft x 10 ft
Floor loading	75 lbs/sq ft
	267 lbs concen max
Weight, computer	3,230 lbs

No special preparation except power requirements and voltage regulators.

COST, PRICE AND RENTAL RATES

Manufacturer

Approximate cost of basic system $97,500.

Rental rate of basic system, standard shift $1,000-$1,275.

Second shift operation charge is an additional 50% of the standard rate.

Third shift operation charge is an additional 50% of the standard rate.

Maintenance, including cost of parts, except due to customer negligence, is included in the rental rates above.

The charge for maintenance to a customer who purchases, rather than leases, but who requires maintenance operations is $4,875 per year for a machine less than 6 years old and $5,850 per year for a machine 6 to 11 years old.

Customer's personnel are trained at no extra charge.

Bureau of Reclamation

	Quantity	Monthly Rental
Univac 120	1	$1,170.00
Keypunch, Type 306-2 alphabetical w/visible automatic feed, 90 column	3	120.00
Verifier, Type 313, 90 column	1	60.00
Sorter, Type 420, Electronic	1	87.50
Interpreter, Type 312-4 Posting	1	155.00
Collating Reproducer, Type 315-1	1	165.00
Alphabetical Tabulator, Series 3200 100 cards/min	1	475.00
Summary Punch, Type 311	1	85.00
Portable Card Punch, Type 102	2	20.00
Electronic Collator, Type 319-2	1	125.00

Maintenance service included.

Dugway P. G.

Calculating Unit and Reader-Punch Unit rent at approximately $1,350 per month.

Tabulator, Interpreter, Sorter, 2 Collators, and 2 Keypunches rent at approximately $900 per month.

Bureau of Mines

Basic system cost $95,783.53 + 5,850.00 excise tax.

Minimum capacity system	$1,125/month
Maximum capacity system	1,350/month
Bureau of Mines system	1,300/month

Maintenance service contract is included in rental.

AiResearch

	Qty Used	Cost Each	Monthly Rental
Univac 120 Computer	2	$97,500	$1,350
Collators	2	10,000	125
Interpreters	2	6,945	--
Tab/Sum	6	31,968	535
Sorters	8	5,600	85
Reproducers	4	9,376	125

Above rentals are for one shift. Second shift are 50% additional.

Maintenance service is included in rental.

PERSONNEL REQUIREMENTS

Bureau of Reclamation

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts	1	1
Operators	2	2
Keypunch Opera	2	2

Operation tends toward open shop.

Prior to installation of hardware at Ephrata, Sperry Rand conducted training seminars for the selected operators. Since installation, the training program has been on an on-the-job basis.

Dugway P. G.

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Programmers	4	4
Clerks	1	1
Operators	1	1
Technicians	1	1

Operation tends toward closed shop.

On-the-job training and Remington Rand machine operation and programming classes are utilized for training.

Bureau of Mines

	One 8-Hour Shift Used	Recommended
Supervisors	1	2
Analysts	2	2
Technicians	1	2

Operation tends toward open shop.

Company sponsored and on-the-job training are utilized.

AiResearch

	Two 8-Hour Shifts Used	Recommended
Supervisors	2	2
Analysts	1	1
Programmers	1	1
Operators	2	2
Engineers	1	1
Technicians	2	2

The supervisors supervise the entire Tab Room and not just the computer operations.

The analyst and the programmer are only part time for the computer.

All Tab Room personnel are capable of operating this equipment.

The engineer and technicians are furnished by the manufacturer and are responsible for all equipment.

Operation tends toward open shop.

Methods of training used include training by manufactirer's personnel and on-the-job training, closely supervised.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Bureau of Reclamation

Good time 20 Hours/Week (Average)
Attempted to run time 21 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period 1 Jan 60 to 30 Jun 60
Passed Customer Acceptance Test 1 Apr 59
Time is available for rent to qualified outside organizations.

Since the volume of applications the unit now processes are of accounting nature, we have some peak periods that exceed the capacity of the machines. However, we do have the capacity to absorb considerable more work, provided the scheduling emphasis could be placed on the non-peaking periods.

Dugway P. G.

Average error-free running period 24 machine hours
Good time 15 Hours/Week (Average)
Attempted to run time 20 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.75
Above figures based on period 1 Aug 59 to 1 Aug 60
Passed Customer Acceptance Test Nov 54
Time is available for rent to outside organizations.

Bureau of Mines

Good time 36 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 1 Jan 60 to 30 Apr 60
Time is not available for rent to outside organizations.

AiResearch

Good time 58.5 Hours/Week (Average)
Attempted to run time 64.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.92
Above figures based on period 1 Jan 60 to 29 Apr 60
Passed Customer Acceptance Test Jan 56
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

The Univac 60 and Univac 120 Systems are similar, except with regard to such items as storage capacity, price, rental rate, and service costs.

Bureau of Reclamation

The Univac 120 automatically checks each arithmetical step of each calculation before proceeding to the next step. Forty program steps of the Univac 120 may be used in any numerical sequence desired. Furthermore, one program step or series of steps can be re-used or repeated as often as required in any calculation. Sperry Rand machines require more careful programming. There are dividends to this, though, in that often through more careful programming we can realize much greater efficiency.

As far as commercial applications are concerned, we find the size of a Univac 120 to be almost ideal. It is not so large as to lure us into over-programming an application; nor is it so small that we have to make repeated runs. Rather it seems to break our computations into sizes which can be effectively and economically handled.

Dugway P. G.

Outstanding features include low cost with punched card versatility. Although the present computer system was adequate for its original purpose, the problems being generated at Dugway are of such a nature that a plugboard programmed computer does not conveniently lend itself to their solution.

AiResearch

Outstanding features include internal checking of all computations, branching on each step, address instructions, and ample selectors give great versatility.

FUTURE PLANS

Bureau of Reclamation

Feasibility studies are being conducted in many areas of our Project Office to determine the applications that are necessary for the EDP unit to be of greater value in reporting to management. With these factors in mind, the equipment requirements could conceivably change. However, additional equipment is not contemplated in the near future.

Dugway P. G.

A local Data Processing Committee is currently studying proposals received from approximately 12 vendors with the view that a small stored program computer would provide Dugway with the programming flexibility that is required in statistical and mathematical research operations. A stored program computer will allow us to solve problems that are not economically feasible with our current system.

AiResearch

Our present system is over 4 years old and has been expanded to the limit of punched cards. To further advance our system, we now have on order two (2) Sperry Rand Univac Solid State Tape Computers (one 80 Col., one 90 Col.) with 5 tape servos each. These are scheduled for delivery in September and November 1960. Initially we are considering these computers as a natural expansion to our present punched card system. As soon as our present system (modified to take advantage of the computers capabilities and magnetic tape) is "on the air", we will start to integrate our runs into a more sophisticated system, but keeping the shock of a new system to a minimum.

INSTALLATIONS

U. S. Bureau of Reclamation
Region 1, Columbia Basin Project
Box 368
Ephrata, Washington

U. S. Army Chemical Proving Ground, Dugway
Test Design & Analysis Office
Dugway, Utah

U. S. Bureau of Mines
4800 Forbes Avenue
Pittsburgh 13, Pennsylvania

AiResearch Manufacturing Company of Arizona
402 South 36th Street
Phoenix, Arizona

PRODUCTION RECORD

Total number of Univac 60 and 120 Systems 1,000

UNIVAC 490

UNIVAC 490 Real-Time System

APPLICATIONS

UNIVAC 490 System is essentially a communications-computer network which provides instantaneous inventory and production control data to companies and government agencies having widely scattered offices, plants and warehouses. Hundreds of transmitting and receiving devices strategically located throughout the country can communicate directly with the central processor. As a result, the computer can receive real-time data from a transaction source, process the raw data and deliver the necessary answers in ample time to complete the original transaction. A wide variety of input and output devices are available to meet specialized requirements.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	30
Binary digits/instruction	30
Instructions/word	1
Instructions decoded	62 function code designators
Arithmetic system	Fixed point
Instruction type	One address
Number range	- 536,870,911 to + 536,870,911 Decimal

Instruction word format

6	3	3	3	15
f	j	k	b	y

f - Function code designator
j - Branch condition designator
k - Operand-interpretation designator
b - Operand address modification designator
y - Operand designator

Automatic coding
Compiler and assembly routines will be supplied to all 490 users.

Arithmetic Registers
Seven B-registers (Address modifying registers 15 bits each)
One A-register or accumulator 30 bits
One Q-register and auxiliary arithmetic register 30 bits
One P-register Program Address Counter 15 bits

Transient Registers
One X-register 30 bits
One K-register 6 bits
One S-register 15 bits
One Z-register 30 bits
One U-register 30 bits
One R-register 15 bits
One R'-register 15 bits
One D-register 30 bits
One C^0-register (Communication Buffer Register)
One C'-register (Communication Buffer Register)

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	7.2-12	4.8-12
Mult	19.2-84	7.2-72
Div	84	72

MANUFACTURER

Sperry Rand Corporation
Remington Rand Univac Division

Construction (Arithmetic unit only)

Transistors	13,819
Diodes	37,543
Arithmetic mode	Parallel

Parallel one's complement binary notation

Timing	Synchronous
Operation	Concurrent

STORAGE

Media	No. of Words	No. of Dec Digits	Access Microsec
Magnetic Core	16,384-32,768	491,520-983,040	1.9
Magnetic Drum Type FH 500	327,680	9,830,400	8,500 avg
Magnetic Drum Type FH 880	786,432	23,592,960	17,000 avg

Magnetic core cycle time is 6 microseconds.

Magnetic Tape UNIVAC Uniservo IIA

No. of units that can be connected As many as 12 Uniservo Model IIA Tape Units may operate through a tape control unit and a channel synchronizer connected to a single input-output channel. The 490 System provides 12 input-output channels. Uniservo Model III may also be used with 490 System.

No. of char/linear inch of tape	125 or 250 Char/inch
Channels or tracks on the tape	8 Tracks/tape
Tape speed	100 Inches/sec
Transfer rate	25,000 Char/sec
Start time	12 Millisec
Stop time	9 Millisec
Average time for experienced operator to change reel of tape	30 Seconds

Physical properties of tape

Width	0.500 Inches
Length of reel	2,500 Feet
Composition	Metallic or Mylar

INPUT

Media	Speed	
Magnetic Tape	125,000 Kilocycle/sec	Model III
Card Reader	600 cards/min	80 Column
Read-Punch Unit	150 cards/min	80 Column
Keyboard and Printer	Printed-page output is 60, 75 or 100 words/minute depending on telegraphic service.	

12 Model IIA Units can be connected to one input-output channel. Can be operated by remote control.

OUTPUT

Media	Speed	
Magnetic Tape	125,000 Kilocycle/sec	
High Speed Printer	600 lines/min	On-line
Read-Punch Unit	150 cards/min	

Keyboard and Printer Because the central site equipment can communicate directly with nearly any type of external digital equipment, remote inquiry answering devices of many different designs can be a part of a 490 System. Usually remote inquiry answering units are especially designed to meet the requirements of a real-time application.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	
Diodes	37,543	All types
Transistors	13,819	All types

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Unit	KVA	Voltage	Phase	Cycle	Voltage Regulator	Heat Dissipation BTU/Hr	Air Requirement Cu Ft/Min	(INCHES) Width	Depth	Height	Weight Lbs.	Floor Loading Lbs/Sq Ft
M490 Computer w/Memory	4.0	208	3	60	± 5%	20,000	1,000	120	36	96	-	-
Flying Head Drum Control Unit (FH 500 and FH 880)	0.25	208	3	60	± 5%	1,000	50	24	30	21	180	36
Flying Head Drum Synchronizer	0.10	208	3	60	± 5%	400	50	24	30	14	120	24
Flying Head Drum Unit	1.3	208	3	60	0	-	-	36	30	40	400	55
Synchronizer, Tape	0.10	208	3	60	± 5%	400	50	24	30	14	120	24
Uniservo Control Unit	0.20	208	3	60	± 5%	750	50	12	30	28	240	48
Uniservo IIA	2.0	208	3	60	± 5%	6,500	350	30	33	66	750	109
Console (Double) Receives from computer central processor						1,100	50	42	18	60	300	60

PRODUCTION RECORD

Number produced to date Prototype 1
Time required for delivery 18 months

PERSONNEL REQUIREMENTS

Appropriate courses will be provided at no cost to the user.

ADDITIONAL FEATURES AND REMARKS

Specially designed for real-time use.
Solid state components with their inherent advantages.
Large expandable capacity high speed storage.
Fast access - high density drum storage.
High internal speed.
Utmost reliability.
Flexible input/output capabilities.
Minimum space.
Low power requirements.
Minimum air conditioning requirements.
Ease of maintenance.
Real-time and delta clocks.

UNIVAC 1101
Universal Automatic Scientific Computer 1101

MANUFACTURER
Remington Rand Univac Division
Sperry-Rand Corporation

Photo by Georgia Institute of Technology Engineering Experiment Station, Rich Electronic Computer Center

APPLICATIONS
Georgia Tech
Commercial and scientific data processing. Education and research in all fields of engineering and science. Provides research assistance to commercial and industrial sponsors.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	24
Binary digits/instruction	24
Instructions per word	1
Instructions decoded	48
Instructions used	43
Arithmetic system	Fixed point
Instruction type	One address
Number range	$1-2^{23}$ to $2^{23}-1$

Negative numbers used are in the ones complement arithmetic. +5 = 00000005 and -5 = 77777772 octal.

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add time	5
Mult time	260
Div time	324
Construction	Vacuum tubes
Basic pulse repetition rate	400 Kc/sec
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

STORAGE

Media	Words	Access Microsec
Magnetic Drum	16,384	32 - 17,000
Magnetic Core	4,096	10

Georgia Tech
A modified 1103A Magnetic Core System has been installed on the 1101. The computer has a 24 binary digit word which is transferred and operated on in a parallel mode.

INPUT
Medium
Paper Tape (35 words, 140 frames, 14 in)/sec

OUTPUT

Media	Speed
Paper Tape (Teletype)	60 char/sec
Typewriter (Flexowriter)	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	2,695	(18 types)
Diodes	2,385	

CHECKING FEATURES
Improper command stops the machine.

PRODUCTION RECORD
Total number of Univac 1100 Series (all models) delivered is 45.

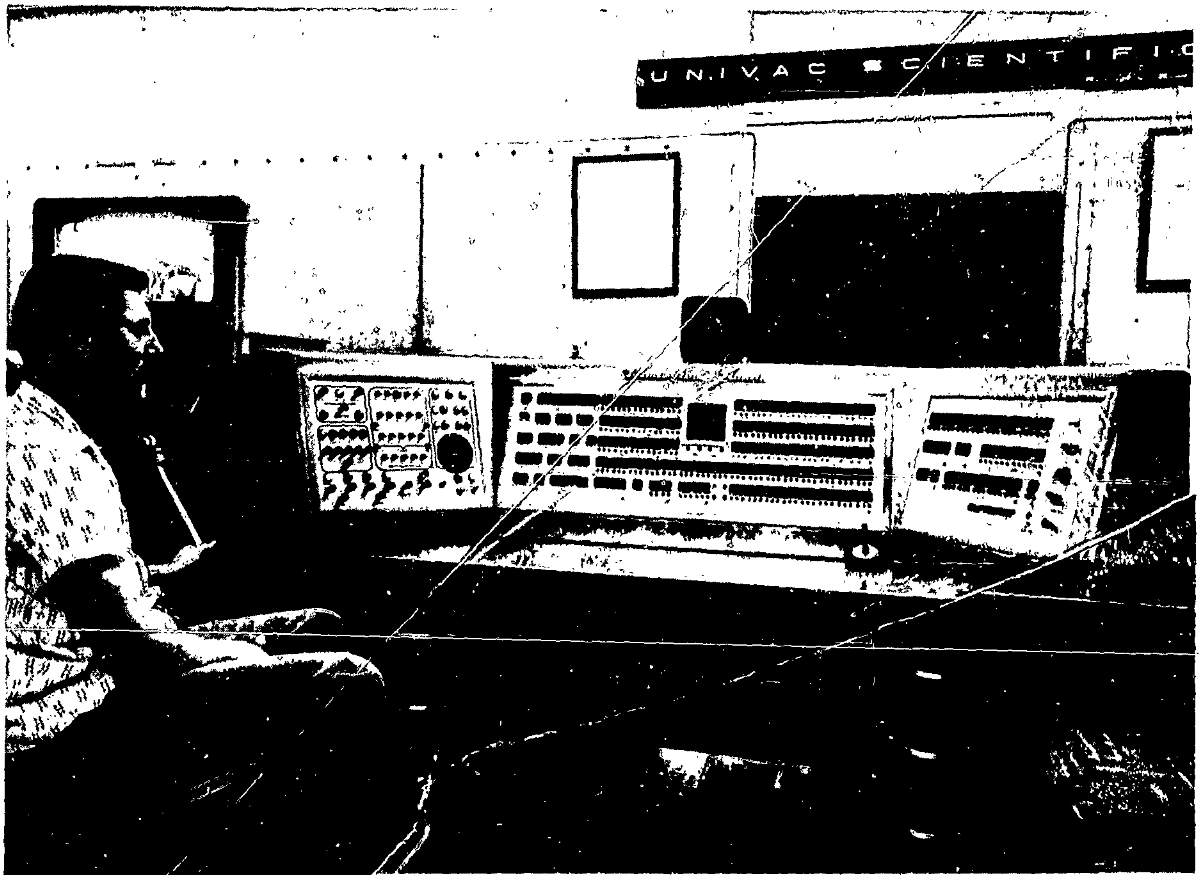


Photo by Georgia Institute of Technology Engineering Experiment Station, Rich Electronic Computer Center

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	16 KVA	0.95 pf
Power, air conditioner	1.2 KVA	(Gas operated)
Space, computer	2,880 cu ft,	360 sq ft
Space, air conditioner	384 cu ft,	48 sq ft
Room size, computer	720 sq ft	
Room size, air conditioner	192 sq ft	
Floor loading	44 lbs/sq ft	
Capacity, air conditioner	5 Tons	
Weight, computer	16,000 lbs	
Weight, air conditioner	1,500 lbs	

False floor (plenum for A.C.). Separate room for M.G. and A.C. Distribution duct from A.C. to computer.

COST, PRICE AND RENTAL RATES

donated to Georgia Institute of Technology d at $500,000).

Core System	$39,000
uipment	4,000 (approx)

ance performed by Georgia Tech staff.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	
	Used	Recommended
	1	1
	2	2
Coders	4	6
	1	1
	1	1
		1
		2

Operation tends toward open shop.

Technician training is conducted at scheduled times and programming courses are offered in the Mathematics Department.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period		5.6 Hours
Good time	34.5 Hours/Week	(Average)
Attempted to run time	38.0 Hours/Week	(Average)
Operating ratio (Good/Attempted to run time)		0.80

Above figures based on period 1 May 60 to 1 Aug 60

Passed Customer Acceptance Test Aug 55

Time is available for rent to outside organizations. Rental is $75.00 per hour (including operator).

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a large library of subroutines, including fixed point, floating point, function evaluation, etc., and stop address interrupt feature.

FUTURE PLANS

The addition of index registers and floating point hardware is being considered and modifications are in progress to add punch card input-output with the Bull Controlled Reproducer with independent input and output buffers.

INSTALLATIONS

Georgia Institute of Technology
Engineering Experimental Station
Rich Electronic Computing Center
Atlanta, Georgia

UNIVAC 1102

Universal Automatic Scientific Computer 1102

MANUFACTURER

Sperry Rand Corporation
Remington Rand Univac Division

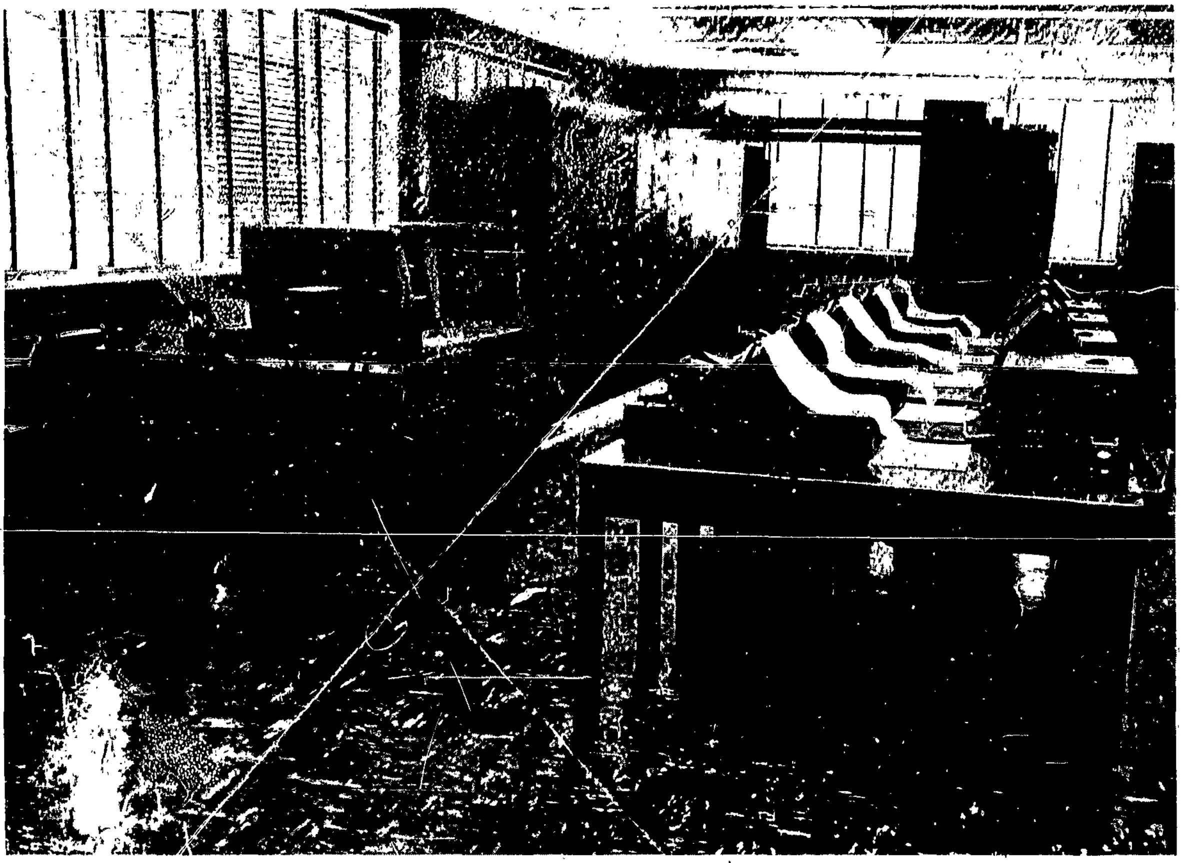


Photo by Arnold Engineering Development Center, ARDC, Tullahoma, Tennessee

APPLICATIONS

Arnold Engineering Development Center
Data reduction in Wind Tunnel and Engine Test Facilities. Three computers are used on-line during wind-tunnel and aerodynamic testing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	24
Binary digits/instruction	24
Instructions per word	1
Instructions decoded	Depends upon program
Octal digits/instruction not decoded	8
Arithmetic system	Left circular shift
Instruction type	One address
Number range	Accumulator holds 48 binary digits

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add time	17 max.
Mult time	264 max.
Div time	340 max.
Construction	Vacuum tubes
Rapid access word registers	1
Basic pulse repetition rate	500 Kc/sec
Arithmetic mode	Parallel

STORAGE

Media	Words	Access Microsec
Magnetic Drum	8,192	8,500 max.

INPUT

Media	Speed
Tape Reader	200 lines/sec
Raw Data Scanner	Scans 252 channels in 12.5 sec or 20/sec.

The raw data scanner is connected to transducers measuring test data.

OUTPUT

Media	Speed
Automatic Typewriter	10 char/sec
Automatic Plotter	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	2,700
Diodes	3,000
Magnetic elements	700 relays
Number of separate cabinets	3
Number of different kinds of plug-in units	47

CHECKING FEATURES

Accumulator overflow indicator
"Oversize quotient" check
Improper operation code check
Address check on tape loading

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	22 Kw
Volume, computer	772 cu ft
Area, computer	122 sq ft
Weight, computer	14,000 lbs
Power, air conditioner	9 Kw
Volume, air conditioner	80 cu ft
Area, air conditioner	12 sq ft
Weight, air conditioner	3,000 lbs
Capacity, air conditioner	25 Tons

PRODUCTION RECORD

Number produced	3
Number in current operation	3

COST, PRICE AND RENTAL RATES

Three computing systems were developed and manufactured under contract. Total cost was approximately $1,400,000.

PERSONNEL REQUIREMENTS

Daily Operation	No. of Eng.	No. of Tech.
One 8 Hour Shift	5	2

Above totals are for one computer.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Arnold Engineering Development Center

The following performance figures are given for the three computers for the period January through September 1956. The last of the three computers was accepted on 1 March 1956. Each column is for a separate engineering facility at the Arnold Engineering Development Center.

	ETF	PWT	GDF
Manned Time	57.0%	25.6%	30.1%
Utilization	51.4%	20.3%	24.8%
Computer Efficiency	87.5%	89.3%	84.4%
Reliability	96.8%	99.3%	97.9%
Scheduled Maintenance	9.5%	10.0%	13.9%
Unscheduled Maintenance	3.0%	0.7%	1.7%
Maintenance Factor	0.331	0.301	0.388

Terms and Definitions of Computer Performance

O - Operational Time - Productive computer hours used in data reduction, engineering problems, program checking, or other productive computations. It does not include hours used in running of check problems for maintenance purposes.

I - Idle Time - Computer hours during which the computer is manned and in condition for productive operation but not in use for such purposes.

U - Unused and Unmanned Time - Hours during which personnel are not scheduled for computer operation.

C - Marginal Checking - Daily routine testing prior to operation to determine that the computer is in operable condition.

P - Preventive Maintenance - Computer hours used for testing of the computer to improve its performance and which does not detract from scheduled operational time.

R - Unscheduled Maintenance - Hours consumed in restoring the computer to operating condition when failure occurs.

C.M. - Concurrent Maintenance - Hours spent in repair and testing of computer components which does not consume computer time.

E.M. - Engineering Modifications - Computer hours used in accomplishing engineering modifications to the computer and its circuitry.

T - Total Time = O + I + U + C + P + R + E.M.

On a daily basis Total Time is twenty-four hours.

Manned Time
100 (T-U)/T

Utilization
100 (O+E.M.)/(O+I+U+E.M.)

Computer Efficiency
100 (O+I+E.M.)/(T-U)

Reliability
100 (O+I+E.M.)/(O+I+R+E.M.)

Scheduled Maintenance
100 (C+P)/(T-U)

Unscheduled Maintenance
100 R/(T-U)

Maintenance Factor
(C+P+C.M.+R)/T-U+C.M.)

UNIVAC 1103 1103A

Universal Automatic Computer Model 1103 - 1103A

MANUFACTURER

Remington Rand Univac Division
Sperry Rand Corporation

Photo by Lockheed Aircraft Corporation

APPLICATIONS

Manufacturer

Scientific computation.

White Sands Missile Range

Integrated Range Mission-DRD, N. M.

Located in Building 1512, White Sands Missile Range, the primary use of the ERA 1103A, is for computations incident to conversion of range flight test data to engineering formats and computations of problems associated with flight simulation and a small amount of general purpose computing for range customers.

3208th Test Gp (TF), APGC (PGVMC)

Eglin AFB, Florida

Located in Building 625, Eglin AFB, Florida, the 1103A is used for impact predictions (real time), slew testing of radars and ballistics.

Air Force Missile Development Center

Holloman AFB, New Mexico

Both systems are used for reduction of data obtained during high speed track tests of inertial guidance systems, e.g. gyro error coefficients, vibration analysis, acceleration and velocity translation to tangent plane coordinates, satellite orbit calculations, and missile performance analysis. Systems are integrated into the Real Time Data Assimilator.

Digital Computation Branch (WWDCD) WADD, W-P AFB

Located in Building 57, WADD, W-P AFB, Ohio, the system is used in the solution of scientific and other R&D problems, in conducting research in numerical analysis and digital computer programming techniques.

National Aeronautics & Space Administration, Lewis Research Center

Located at the NASA-Lewis Research Center, 21000 Brookpark Road, Cleveland 35, Ohio, the system is used for reduction of experimental data from wind tunnels, test stands, rocket stands, etc., engineering and scientific analysis-type problems.

Experimental data is recorded on automatic recorders of our own design. The punched paper tapes and/or magnetic tapes are fed into the computer, calibrated,

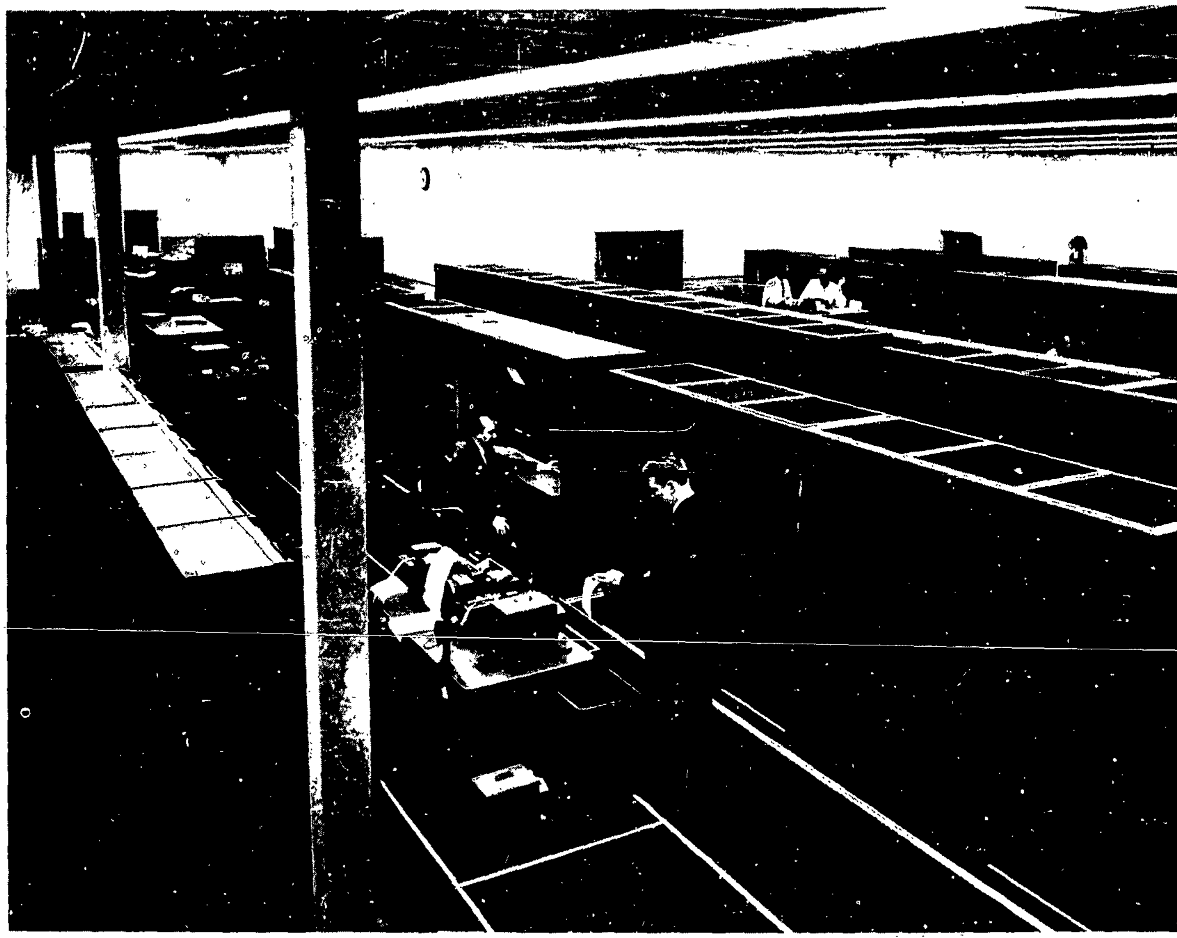


Photo by Lockheed Aircraft Corporation

and mathematical operations carried out to produce the quantities specified by the test engineer. Scientific problems of all types are punched into paper tapes by a Flexowriter, fed into the computer, and the mathematical operations specified by the programmer are performed.

Lockheed Missile and Space Division
Located at Palo Alto, California, the 1103AF (2 computers) systems are primarily used for trajectory calculations and real time orbital predictions.

Johns Hopkins University, Applied Physics Lab.
Located at Johns Hopkins Road, Scaggsville, Howard County, Maryland, the 1103A is used for scientific computations in support of the Laboratory's research and development programs.

Johns Hopkins Univ., Operating Research Office
Located at the Computing Laboratory Division, 6935 Arlington Road, Bethesda 14, Md., the 1103A is used for operational simulation, including war gaming, and scientific data processing.

Computing Laboratory, Southern Methodist Univ.
Located at 3175 Yale, S. M. U. Campus, Dallas, the 1103 is used for education and research.

Numerical Analysis Center, University of Minnesota
Located in Room 230, Exp. Engineering Building, University of Minnesota, the 1103 is being used in statistical work to do such things as factor analysis (16 variables), multiple regression, analysis of variance, item analysis of tests, product moment correlations, linear and quadratic discriminant finctions, reciprocal average analysis, and several specialized projects. It is used in crystallography to determine atomic structure of crystals from X-ray diffraction data; in aerodynamics to analyse transonic flow boundary layers, buckling of sandwich panels, detonation wave structure; in electrical engineering to study acoustic coupling, micromagnetics, and ferrmagnetic microstructure; in mathematics to do continued fraction expansions, analyse the four-color map problem; in mechanical engineering to study mass transfer cooling, non-circular duct flow, to design a probe for measurement of flame temperature, to study the transport properties of helium-air mixtures; in chemistry to study the kinetics of chemical reactions, light scattering, and energy levels of linear molecules; in chemical engineering to study nuclear reactor simulation and control, kinetics of polymerization, stability of loop processes, optimum design of a chemical reactor, perturbation transients in a distillation tower, kinetics of a nuclear reactor; in physics to compute instrument corrections for data on

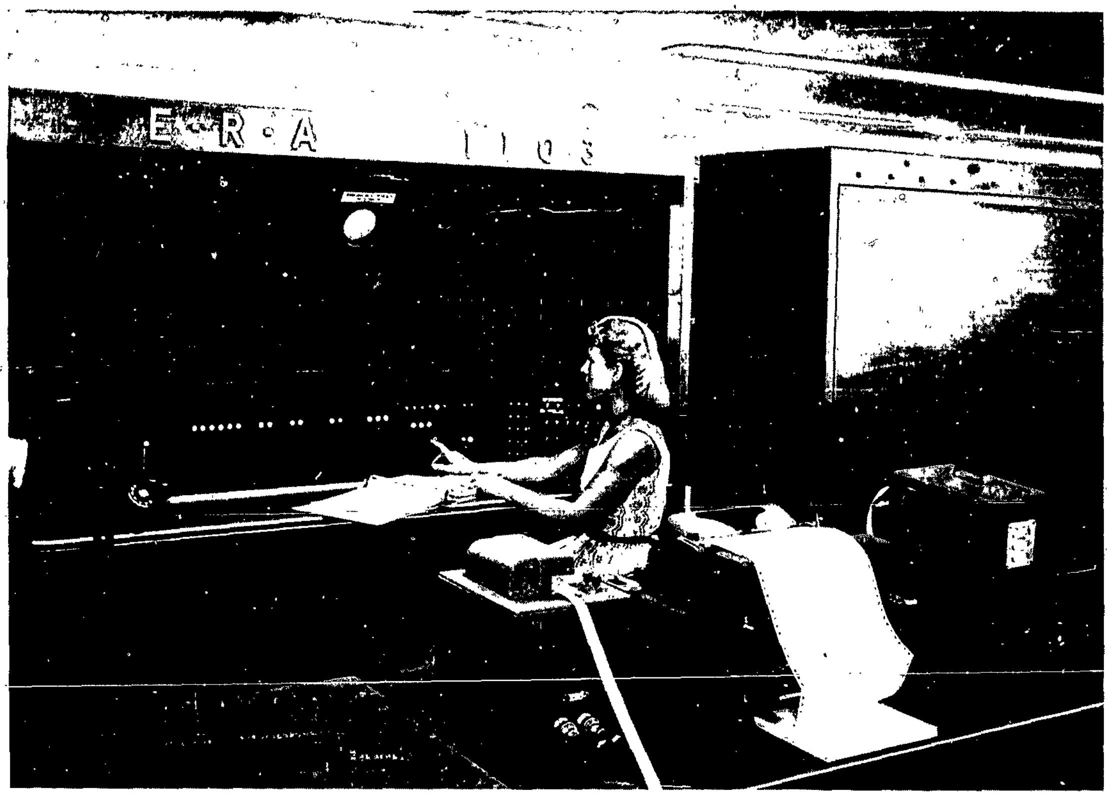


Photo by NASA Lewis Research Center

black body radiation taken from numerous balloon flights, to compute cosmic ray orbits in the earth's magnetic field and proton trajectories in an optical potential, analysis of nuclear stripping reactions, compute the IGY cosmic ray index, analyse the Van Allen zones; in agronomy and plant genetics to analyse hybrid corn performance; in animal husbandry to study breeding programs involving large populations and many generations; and in physical chemistry to determine normal coordinates of molecular vibration.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36
Binary digits/instruction	36
Instructions per word	1
Instructions decoded Model 1103	41
Model 1103A	50
Arithmetic system	Fixed and floating point
Instruction type	Two address
Number range Fixed point	$(1-2^{35}) \leq n \leq (2^{35}-1)$
Floating point	$-2^{127} \leq n \leq 2^{127}$

The instruction consists of a 2-character operating code (command), a 5-character First Address and a 5-character Second Address.
The floating point system utilizes nine instructions.
Fixed point operation utilizes 41 instructions.
There are two 15 bit addresses per word. This facilities writing of programs, since less instructions are required, less storage is consumed in storing program, and a smaller repertoire of instructions has to be learned by the programmer.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	32-60	12-28
Mult	116-410	92-386
Div	482-490	466-474

Construction	Vacuum tubes
Basic pulse repetition rate	500 Kc/sec
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

Operation times given above are average values. Add time includes transmitting result to V address. Multiply time is for product to form in accumulator with multiplier in "O" register. Divide time includes quotient in "O" register and positive remainder in the accumulator. The arithmetic unit is constructed of Eccles-Jordan flip-flop type circuits triggered by pulses from pentode "gate" circuits which are "enabled" by either other flip flops or signals from "AND" or "OR" circuits. The flip flops may be manually controlled from the console. Although the arithmetic mode is parallel, all operations pass through the exchange register "X". The "X", "O", and "A" registers separately and in combination are used to form eleven distinct logical and arithmetic sequences.

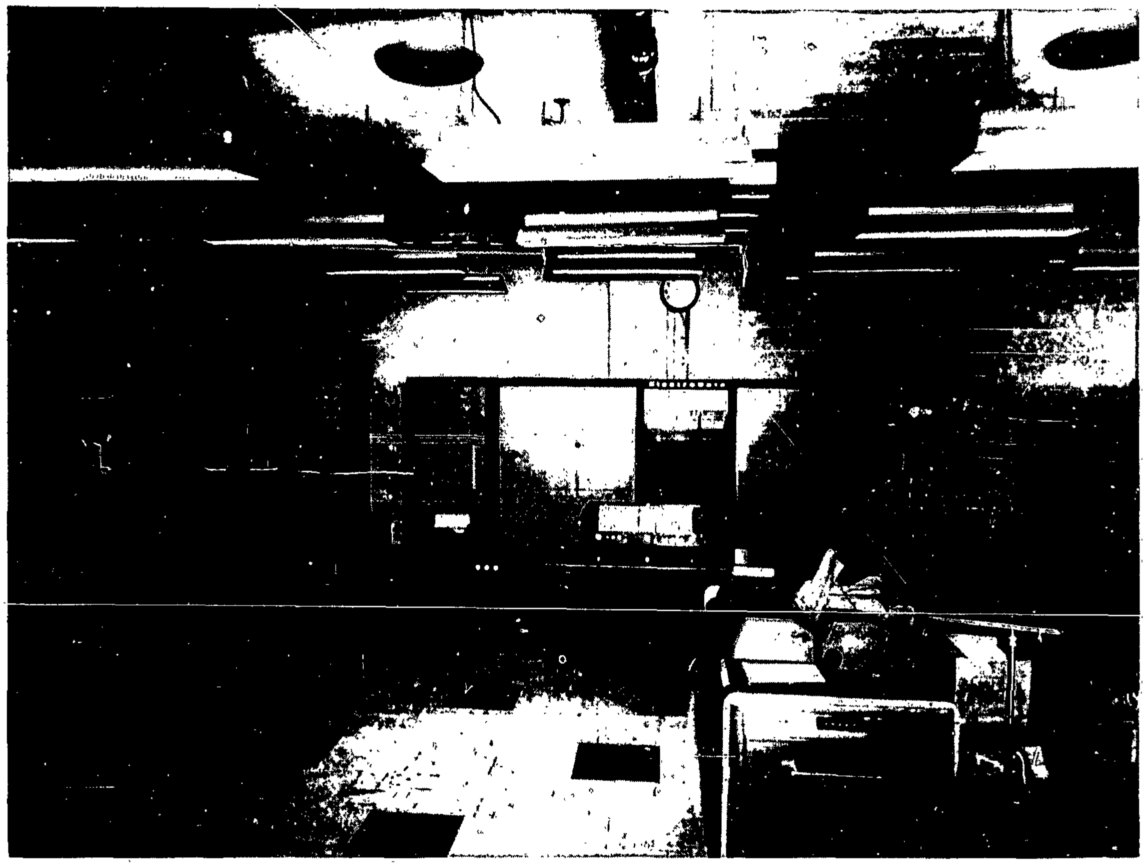


Photo by WWDCD Wright Air Development Division

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4,096	147,456	8
Magnetic Core	4,096	147,456	8
Magnetic Core	4,096	147,456	8
Magnetic Drum	16,384	589,824	17,500

The magnetic core matrix is 64 x 64 bits. The matrices are stacked in groups of 36. Up to three stacks may be used as high speed storage. The magnetic drum is a medium speed storage system. The magnetic tape Uniservos store 326,000 words of low speed storage. Up to 10 Uniservos can be accommodated.

WSMR IRM

Magnetic Core	8,192		8
Magnetic Drum	16,384		

0 to 34 milliseconds for 1st word, 32 microsec/word thereafter.

Magnetic Tape 326,000 words/tape

Computer is equipped with 10 Uniservo I's up to 8 of which may be used for information storage at programmer's discretion.

Eglin AFB

Drum	16,384		
Core	4,096		

Holloman AFB

Magnetic Core	4,096	147,456	8
Magnetic Drum	16,384	589,824	17,500

Media	No. of Words	No. of Digits	Access Microsec
W-P AFB			
Drum	16,384		
Core	12,288		
NASA Lewis			
Magnetic Core	4,096		6.0
Magnetic Drum	16,384		17,000 avg.
Lockheed			
Magnetic Core	8,192	294,912	8
Magnetic Drum	16,384	589,824	17,000
Magnetic Tape	1,500,000	54,000,000	20,000
Internal Registers	3	108	4

Tape access time depends on the position of the tape. In most cases, however, the access time is 20 milliseconds.

Johns Hopkins APL

Core	8,192	284,912	8
Drum	16,384	589,824	17,500

Floating point a feature.

Johns Hopkins ORO

Magnetic Core	4,096		
Magnetic Drum	16,384		

Southern Methodist

Magnetic Core	1,024		8
Magnetic Drum	16,384		33,000
Magnetic Tape	65,536		

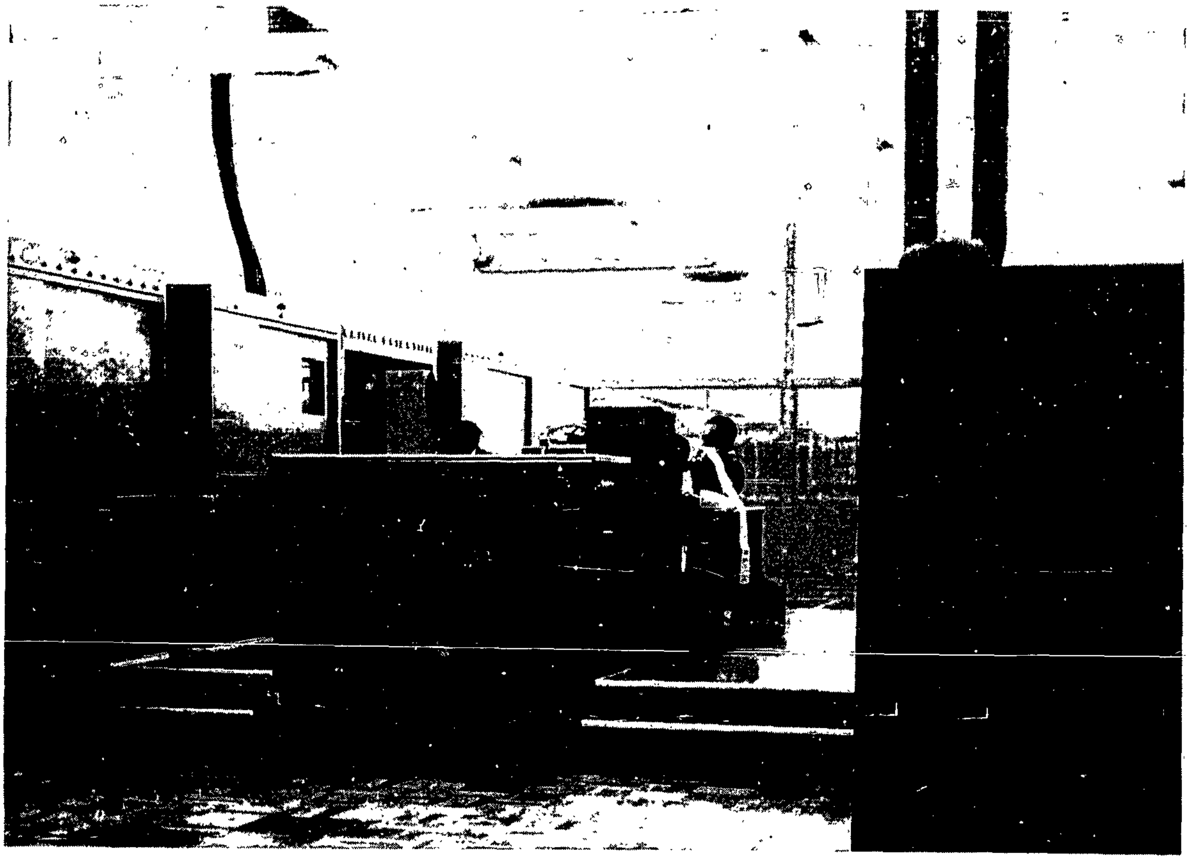


Photo by Air Force Missile Development Center, Holloman AFB

Media	No. of Words	Access Microsec
Electrostatic (CRT)	1,024	8
Magnetic Drum	16,384	17,000 (avg)
Magnetic Tape	262,144	2 min (avg)

INPUT

Manufacturer

Media	Speed
Magnetic Tape	2,130 words/sec
Tape Reader	200 frames/sec
Card Reproducer	120 cards/min

The magnetic tape speed is given for the continuous input mode. The tape reader senses 2 octal digits/frame. The card reproducer uses 80-column cards, placing 24 words on a card. Special equipment, such as analog-to-digital converters can be used as optional equipment. By means of input-output buffer registers, a variety of input or output equipment can be accommodated by the computers.

WSMR IRM

Uniservos	1,800 words/sec
IBM Card Punch	48 words/sec
High Speed Paper Tape Reader	35 words/sec
BRL High/O Magnetic Tape Reader	555 words/sec

Media	Speed
Eglin AFB	
Control Reproducer	120 80 column IBM cards/min (on-line)
Uniservo Magnetic Tape	2,137 words/min (on-line)
Ferranti Paper Tape Reader Milgo	220 frames/sec (on-line)
Holloman AFB	
Magnetic Tape (Uniservo) Continuous read.	2,130 words/sec
Paper Tape	200 frames/sec
Punched Cards	120 cards/min
Magnetic Tape (IBM Format) Continuous read.	5,000 words/sec
Magnetic Tape Ampex FR 316.	450,000 bits/sec
W-P AFB	
Magnetic Tape	100 in/sec 12,000 char/sec
Paper Tape	200 frames/sec 400 char/sec octal
Punched Card	120 cards/min
NASA Lewis	
Magnetic Tape (2 channel)	320 char/sec (data tape)
Magnetic Tape (7 channel)	8,000 32,000 char/sec (data tapes)
Magnetic Tape (Buffered)	33,000 char/sec (I/O or intermediate tape)
Paper Tape	200 char/sec (programs and/or data)

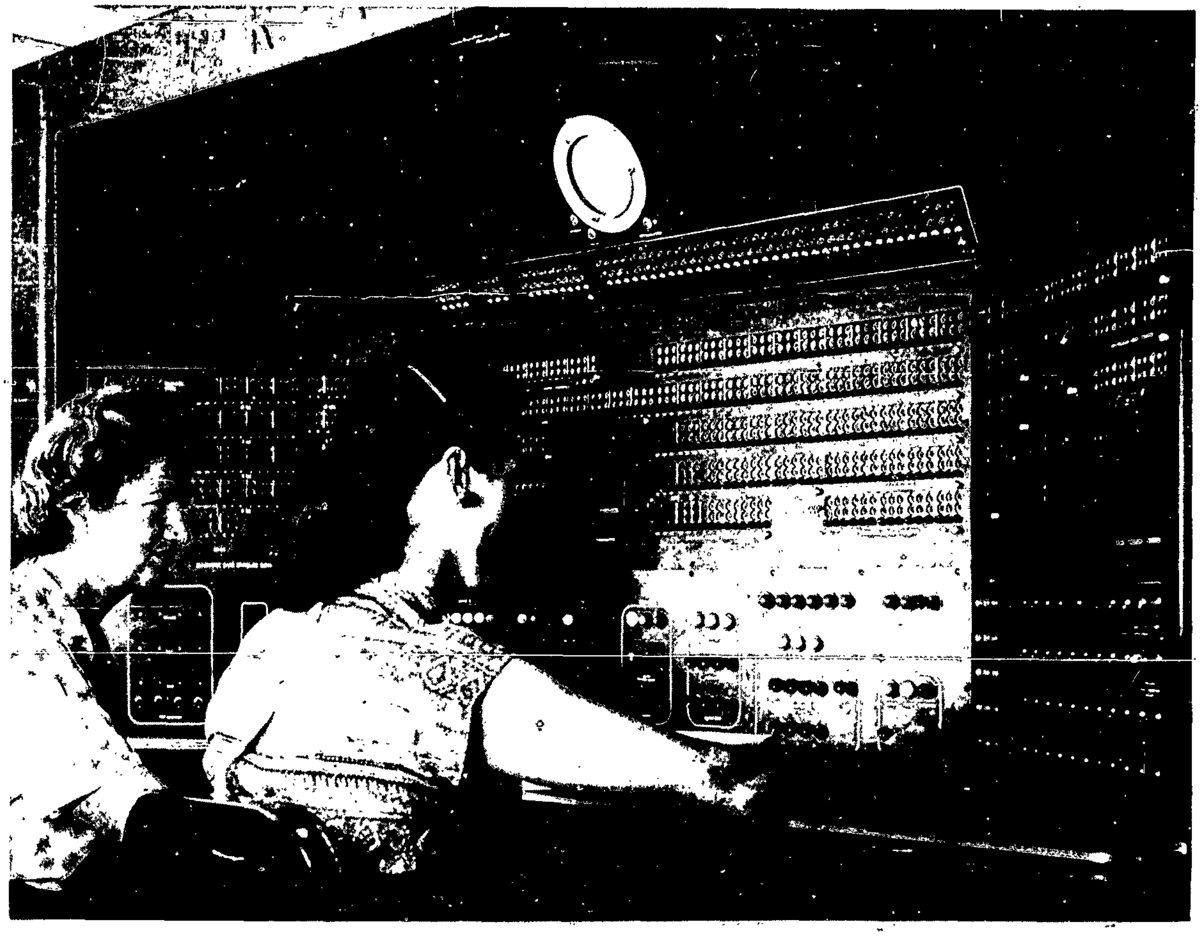


Photo by White Sands Missile Range, New Mexico

Media	Speed
Lockheed	
Paper Tape	400 octal dig/sec
Magnetic Tape	25,600 octal dig/sec
Punched Cards (80 column)	120 cards/min
Johns Hopkins APL	
Card	120 cards/min
Magnetic Tapes (8 units)	12,500 char/sec
Paper Tape	200 char/sec
Johns Hopkins ORO	
Punched Cards	
Paper Tape	
Magnetic Tape	
Southern Methodist	
Paper Tape (Ferranti)	200 char/sec
Card Reader (Bull)	120 cards/min
U of Minn	
Paper Tape (7 channel) (Ferranti Mark II Photoelectric)	200 frames/sec
Cards (80 col.) (Bull controlled reproducer)	120 cards/min

OUTPUT

Manufacturer Media	Speed
Magnetic Tape (Uniservo) Continuous write.	2,130 words/sec
High Speed Printer	600 lines/min 130 char/line
High Speed Punch	60 frames/sec 2 char/frame
Card Reproducer (80 Col.)	120 cards/min 24 words/card
Flexowriter	Supplied as monitor
WSMR IRM	
Uniservo I Magnetic Tape	1,800 words/sec
IBM Card Punch	48 words/sec
Paper Tape	10 words/sec
Eglin AFB	
High Speed Punch	120 frames/sec (on-line)
Charactron Display & Manual Intervention Sys.	10,000 times/sec (on-line)
High Speed Printer	600 lines/sec (off-line)
Flexowriter	10 char/sec (on-line)
Variplotter	

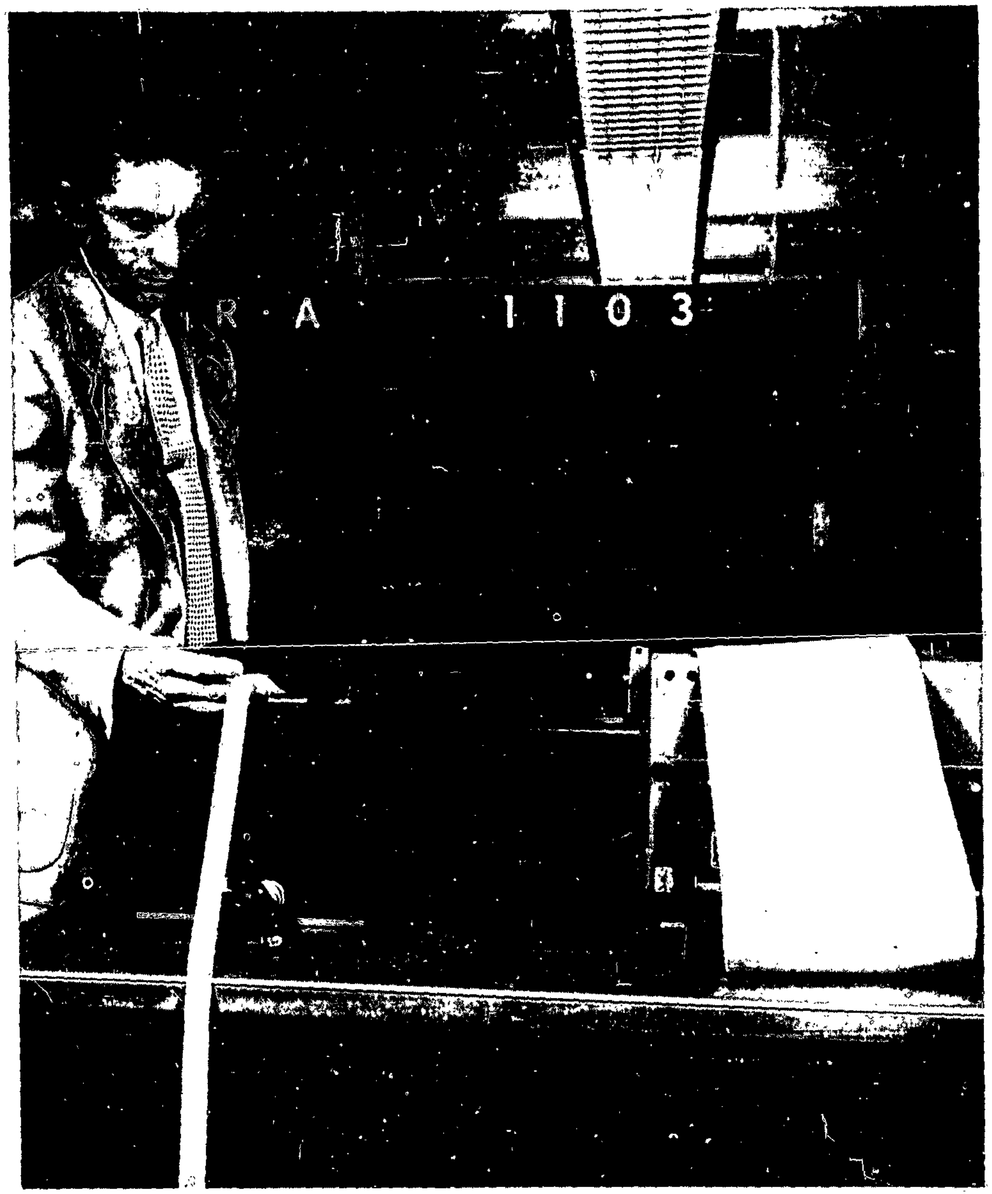


Photo by White Sands Missile Range, New Mexico

Media	Speed
Holloman AFB	
Magnetic Tape (Uniservo) Continuous write.	2,130 words/sec
Paper Tape	60 frames/sec
Punched Cards	120 cards/min
Magnetic Tape (IBM Format) Continuous write.	5,000 words/sec

The system contains special buffers, so-called loading platforms, for real time input of test data, a common memory for communication between two Univac Scientifics and on-line equipment for output, like digial, analog converters, display.

Media	Speed
W-P AFB	
Magnetic Tape	100 in/sec
	12,000 char/sec
Paper Tape	60 frames/sec
	120 char/sec, octal
Punched Cards	120 cards/min
On Line Monitor Flex	10 char/sec

Off-line tape to printer is main output method, using the Univac High Speed Printer (600 lines/min).

Media	Speed
NASA Lewis	
Paper Tape Punch (3)	60 char/sec, each
Magnetic Tape (Buffered)	33,000 char/sec

Photo by Eglin Air Force Base, Florida (APGC)

Media	Speed
Lockheed	
Paper Tape	400 digits/sec
Magnetic Tape	25,600 octal digits/sec
Punched Cards (80 Column)	120 cards/min
Flexowriter	60 char/min
Johns Hopkins APL	
Cards	100 cards/min
Magnetic Tape	12,500 char/sec
Paper Tape	60 char/sec
On Line Printer	600 lines/min
	120 char/line
Johns Hopkins ORO	
Punched Cards	
Paper Tape	
Magnetic Tape	
Off-line High Speed Printer	
Southern Methodist	
Paper Tape	3,500 char/min
Cards (Bull)	120 cards/min
Flexowriter (On-line)	160 char/min
U of Minn	
Paper Tape (7 channel) (Teletype Punch)	60 frames/sec
Cards (80 Col.) (Bull controlled reproducer)	120 cards/min

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	3,907
Tube types	12
Crystal diodes	8,956
Magnetic cores	147,456
Uniservo Magnetic Tape Units	77 tubes, each add'l
Card Reproducer Unit	211 tubes, add'l

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer 82 KVA 0.9 pf
220 volt, 3 phase, 100 KVA min, including cooling blower.

Space, computer 946.3 sq ft
Minimum room size 58 ft 6 1/4 in x 30 ft 6 in

Weight, computer 38,543 lbs

Floor loading 40.7 lbs/sq ft

Capacity, air conditioner Required equivalent capacity is 20 Tons.

Two voltage regulators, 3 phase, 45 KVA, required.

Customer furnished cooling water 50°F 65 gal/min, required.

Separate maintenance area approximately 14 x 24 ft, required.

WSMR IRM

Power, computer & air conditioner	100 KVA	0.90 pf est.
Area, computer & peripheral equipment	1,047 sq ft	
Area, air conditioner	55 sq ft	

Area does not include roof space for cooling towers

Room size, maint area & computer proper	40 ft x 80 ft (approx)
Floor loading	35 lbs/sq ft 80 lbs concen max
Capacity, air conditioner	50 Tons
Weight, computer & peripheral equipment	51,610 lbs

Air conditioner is water cooled type. Heat exchangers may be located remotely from computer.

No special provision is required since plenums, false floors, etc. are included as part of the system. Also motor alternator for providing constant voltage power to pulsing circuits is provided. Preparation is confined to 2 inch pipe lines for delivery of chilled water from computer to heat exchanger and from heat exchanger to room cooling towers and provision for power distribution. Separate transformer vaults are provided from post primary system for computer in order to stabilize voltage. Separate voltage alternator is provided by manufacturer for pulsing circuits. 50 hp. If newly designed room should provide a minimum of 30 ft clear span with no columns; however, machine can be installed around columns if required.

Eglin AFB

Power, computer	60 Kw	55 KVA	0.92 pf
Power, air cond	28 Kw	26.6 KVA	0.95 pf
Volume, computer		9,360 cu ft	
Volume, air conditioner		432 cu ft	
Area, computer		1,560 sq ft	
Area, air conditioner		72 sq ft	
Room size		10 ft (height) 60 ft (length) 33 ft (width)	
Floor loading		21.5 lbs/sq ft	
Capacity, air conditioner		30 Tons	
Weight, computer		33,600 lbs	
Weight, air conditioner		10,790 lbs	

False floor 15 1/2 in. above sub-floor level. Requires a motor room to house the motor-alternator which is supplied with 208 v, 60 cycles/sec, three phase, four wire arrangement for power to the computer and air conditioning system. Shielded room or screen room used to keep out the electromagnetic radiations of nearby electronic equipment.

Holloman AFB

Power, computer approx 50 Kw	55 KVA	0.90 pf
Volume, computer	3,000 cu ft (approx)	
Area, computer	925 sq ft (approx)	
Room size	56 ft 6 1/4 in x 31 ft 2 1/2 in min.	
Floor loading	40.7 lbs/sq ft 500 lbs concen max	

Chilled water supply: 65 gallon/minute maximum at 50°F maximum. Condensation drain. Installation and wiring of motor alternator.

W-P AFB

Power, computer	100 KVA
Volume, computer	10,700 cu ft
Volume, air conditioner	575 cu ft
Area, computer	1,780 sq ft
Area, air conditioner	82.5 sq ft
Room size	70 ft x 40 ft
Floor loading	40.7 lbs/sq ft
Capacity, air conditioner	30 Tons
Weight, computer	38,540 lbs

Provided partitions to enclose room for humidity control.

NASA Lewis

Power, computer	50 KVA
Power, air conditioner	18 KVA
Volume, computer	12,500 cu ft
Volume, air conditioner	3,000 cu ft
Area, computer	1,250 sq ft
Area, air conditioner	300 sq ft
Room size, computer	65 ft x 30 ft
Room size, air conditioner	20 ft x 15 ft
Floor loading	100 lbs/sq ft
Capacity, air conditioner	25 Tons

Platforms used as plenum chamber and cable space. Separate power feeder. Insulated water lines from basement to second floor. Concrete pad for water chiller. Existing building construction was reinforced concrete.

Lockheed

Power, computer	60 Kw	60 KVA	1.0 pf
Power, air cond	4.05 Kw	5.05 KVA	0.8 pf
Volume, computer		9,000 cu ft	
Area, computer		1,500 sq ft	
Room size		60 ft x 26 ft	
Capacity, air conditioner		15 Tons	
Weight, computer		34,000 lbs	

False floor, motor generator and alternator for each computer, air conditioning unit for each computer, and room air conditioning.

Johns Hopkins APL

Power, computer	130 Kw	130 KVA	0.9 pf
Power, air cond	60 Kw	60 KVA	0.9 pf
Volume, computer		10,500 cu ft	
Volume, air conditioner		1,500 cu ft	
Area, computer		1,500 sq ft	
Area, air conditioner		250 sq ft	
Room size, computer		2,000 sq ft	
Room size, air conditioner		400 sq ft	
Floor loading		36.6 lbs/sq ft	
Capacity, air conditioner		50 Tons	
Weight, computer		55,000 lbs	
Weight, air conditioner		8,000 lbs	

Prefabricated metal Butler building.

Johns Hopkins ORO

Power, computer	60 Kw	45 KVA	0.9 pf
Power, air cond		30 KVA	
Area, computer		1,200 sq ft	
Area, air conditioner		300 sq ft	
Room size		58 ft x 30 ft	
Floor loading		40.7 lbs/sq ft	
Capacity, air conditioner		3 - 20 Ton units 40 Tons required	
Weight, computer		38,543 lbs	

Present 1103A Computing System replaced an ERA 1103 Computer; therefore, installation costs and building modifications were minor - amounting only to installing 2 additional 20 ton water chillers and additional electric power. Total cost of present installation was less than $30,000. Cost of initial 1103 installation was also under $30,000 since the 1103 series equipment is provided with a raised floor plenum and air handler.

Southern Methodist

Power, computer	41.5 Kw	0.9 Lag pf
Volume, air conditioner	126 cu ft	
Area, computer	755.5 sq ft	
Area, air conditioner	21 sq ft	
Room size, computer	26 ft x 60 ft	
Room size, air conditioner	6 ft x 7 ft	
Floor loading	46.1 lbs/sq ft	
Capacity, air conditioner	20 Tons	
Weight, computer	34,747 lbs	

3 phase, 220 volt, 60 cycle and 115, single phase, 60 cycle power to building. Cooling tower is required with building to supply water for air conditioner.

U of Minn

Power, computer	44.0 Kw	0.9 induct. pf
Power, air conditioner	22.0 Kw	
Area, computer	710 sq ft	
Area, air cond & motor gen.	280 sq ft	
Room size, computer	58.5 ft x 25.75 ft min	
Room size, air conditioner	14 ft x 20 ft	
Floor loading	46.1 lbs/sq ft	
Capacity, air conditioner	20 Tons min.	
Weight, computer	34,747 lbs	

The required space on the second floor of a laboratory building was given a false ceiling and a strengthening sub-floor, and partitions were erected to form three offices and an off-line input-output preparation room for three Flexowriters and a card punch. Partitions in the basement were erected to form a room for the motor-generators and the air conditioning chiller and a room for the air conditioning condenser.

COST, PRICE AND RENTAL RATES

WSMR IRM

Computer with card input output from 10 Uniservos and floating point with two cores approx. cost $32,115.

Card-to-tape converter, tape-to-card converter, high-speed printer (600 lines/min with plotting feature) $8,815.

Service is provided with basic rental rate.

Eglin AFB

Total cost $922,000.

Magnetic Core Storage (4,096 words)
Magnetic Drum Storage (16,384 words)
Magnetic Tape Control
Power Supply
Desk Console
Arithmetic Section
Main Control Section
Air Conditioning Section
The direct connected input/output units are:
(1) Photo-electric punched paper tape reader
(2) High Speed Paper Tape Punch
(3) Monitoring Flexowriter

Additional Equipment	Cost
Controlled Reproducer	$ 55,000
High Speed Printer	185,000
Charactron Display & Manual Intervention System	325,000

6 Uniservo Tape Units and 1 Unityper II (without maintenance) rents for $27,000/year.

Vitro maintenance engineer plus spare parts is $115,000.

Holloman AFB

Basic system

Computer including one core bay (4,096 words, 5 Uniservos, one punched card input-output unit $1,029,500.

Additional equipment

One Uniservo $18,000
One additional core bay, approx. $200,000
High Speed Printer $3,890/month
$4,370.50/month for eight-hour shift.

W-P AFB

1103A w/float point, 12K core, 16K drum, 10 Uniservo I, Bull Card I/O (80 col), Univac HS Printer rent at $41,000/month.

Maintenance service included in rental.

NASA Lewis

Basic system cost $920,094.

Additional equipment cost $313,939, including Flexowriters, input-output equipment and circuitry, buffered tape installation, new memory.

Lockheed

Type	Unit	Serial No.	Monthly Rental	Hourly Rate	Extra Shift per Hour
	Univac	22	$20,980.00	$119.20	$59.60
	Core Storage		4,500.00	25.57	12.79
	Floating Point		1,545.00	8.78	4.39
	Variable Block		290.00	1.65	.83
	Total Main Frame		27,315.00	155.20	77.61
	Uniservo (10)		3,200.00	18.18	9.09
	Read Punch		890.00	5.06	2.53
	Total On Line		4,090.00	23.24	11.62
	Total EDP No. 22		31,405.00	178.44	89.23
	Univac	27	20,980.00	119.20	56.60
	Core Storage		4,500.00	25.57	12.79
	Floating Point		1,545.00	8.78	4.39
	Variable Block		290.00	1.65	.83
	Total Main Frame		27,315.00	155.20	77.61
	Uniservo (10)		3,200.00	18.18	9.09
	Read Punch		890.00	5.06	2.53
	Total On Line		4,090.00	23.24	11.62
	Total EDP No. 27 (C+D)		31,405.00	178.44	89.23
	High Speed Printer		3,300.00	18.75	9.38
	High Speed Printer		3,300.00	18.75	9.38
	Card to Tape		2,605.00	14.80	7.40
	Total Off Line		9,205.00	52.30	26.16
	Total EDP Systems		72,015.00	409.18	26.16
026	Key Punch	19133	77.00	.43	.22
026	Key Punch	30566	71.50	.41	.20
026	Key Punch	30624	71.50	.41	.21
056	Verifier	40595	60.50	37	.19
	Total Key Punch		280.50	1.62	.82
077	Collator	36399	126.50	.72	.36
082	Sorter	36338	68.20	.39	.20
407	Acctg. Mach.	16001	915.75	5.20	2.60
519	Reproducer	17299	178.20	1.01	.51
552	Interpreter	25483	99.00	.56	.23
	Total Auxiliary		1,387.65	7.98	3.90
	Total EAM		1,668.15	9.60	4.72
	Total system		73,683.15		

Monthly rental includes 10% F.E.T. where applicable.
Hourly rate is 1/176th of monthly rental.
Extra shift per hour is 50% of 1/176th of monthly rate.

Johns Hopkins APL

$35,135 per month for basic system on prime shift and at 50% rate for extra shift use.

Maintenance service, included in monthly rental shown above.

Johns Hopkins ORO

Basic system

4,096 magnetic core, 16,384 magnetic drum, 6 magnetic tape units, Fixed point arith., punched card in-out, and high speed printer (off-line). Single shift cost $24,838/month.

Additional equipment

Three 026, one 024, one 082, one 519, one 552, one 077, and one 407 rents for $1,709.00.

Maintenance service included in rental rates.

Southern Methodist

Rental traded for building space.

U of Minn
$250,000 for complete 1103 (Serial 4).
$100,000 for installation and air conditioning.
$60,000 for REAC installation (Reeves Electronic Analog Computer).
$40,000 for ADDALINK Analog-Digital, Digital-Analog Converter.

PERSONNEL REQUIREMENTS

WSMR IRM

	Two 8-Hour Shifts Used	Recommended
Supervisors	5	5
Analysts	5	8
Programmers	8	12
Clerks	1	1
Operators	9	9
Engineers	6	6
Technicians	1	2
In-Output Oper	4	4

Operation tends toward closed shop.

Operators after a 90 day indoctrination assignment elsewhere within the division are assigned to the computer with a combination of on-the-job and a six week course taught periodically by our own personnel. Programmers are normally hired as professional mathematicians with strong physics background and are assigned initially in other sections of the organization to familiarize themselves with the mathematical and physical problems which they are concerned with. At the conclusion of approximately 1 year assignment in this area programmer trainees are selected and after attending a six week training course either taught in house or at the manufacturer's plant are given on-the-job assignments. Six months to a year are required to provde proficient programmers for our operation after selection and assignment to the computing laboratory. Training of technicians and engineers is a responsibility of the manufacturer and are provided by him.

Programmer training in this activity is more concerned with teaching new employees the techniques and approaches used in solution of range instrumentation problems. This is more difficult than teaching the art of programming of computers. The period prior to assignment to computers is used to screen out prospective programmers who do not have what our management considers to be desirable qualities and traits for this particular type of operation.

Eglin AFB

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Operators	2	2
In-Output Oper	1	1

Operation tends toward closed shop.

Methods of training used includes on-the-job training, organized programming classes, and contractor courses.

Holloman AFB

	One 8-Hour Shift Used	Recommended
Supervisors	4	4
Analysts	4	6
Programmers	12	20
Coders	0	2
Clerks	1	2
Librarians	2	3
Operators	3	5
Engineers	2	2
Technicians	5	5
In-Output Oper	1	2

Operation tends toward closed shop.

Methods of training used are for programmers: Remington Rand programming course plus on-the-job training; and others: on-the-job training.

W-P AFB

	Three 8-Hour Shifts Used	Recommended
Supervisors	5	5
Analysts	5	9
Programmers & Coders	25	30
Clerks	2	3
Librarians	0	1
Operators	8	8
In-Output Oper	4	6

Methods of training used includes formal classes by company representatives and by operating installation and extensive "on-the-job" training.

Open shop operation attempted with limited success, probably due to training in machine coding. Plan to use FORTRAN extensively on open-shop basis with the IBM 7090.

NASA Lewis

	Three 8-Hour Shifts Used	Recommended
Supervisors	2	3
Analysts	2	4
Programmers	18	30
Coders	12	20
Clerks	0	1/2
Librarians	0	1/2
Operators	7	9
Engineers	2	4
Technicians	8	8

Operation tends toward closed shop.

Supervisors, analysts, programmers, engineers should have professional degrees, then on-the-job training. All others can be subprofessional or wage board, with on-the-job training.

Lockheed

	Three 8-Hour Shifts Used	Recommended
Supervisors	1	1
Analysts	2	2
Programmers	15	15
Clerks	1	1
Librarians	1	1
Operators	11	11
Engineers	6	7
Technicians	3	4
In-Output Oper	4	5

These systems are currently operating on production jobs, with little check out on new programming. Above figures are for two computers.

Operation tends toward closed shop.

Operator training is primarily done on-the-job.

Johns Hopkins APL

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	3	4	5
Analysts	1	2	3
Programmers	15	20	25
Clerks	2	3	4
Librarians	1	1	2
Operators	4	6	9
In-Output Oper	3	4	6
Tape Handlers	1	1	1

Operation tends toward closed shop.

Methods of training used includes formal instruction, provided by computer manufacturer, formal instruction provided by our training officer, and on-the-job training at own installation.

Johns Hopkins ORO

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	U	R	U	R	U	R
Supervisors	1					
Analysts	6	10				
Programmers	20	30				
Engineers	3	3	2	2	2	2

The personnel listed above reflect only the Computing Laboratory staff. Throughout the organization there are approximately 60 persons classified as analysts or research assistants who are highly competent programmers. Personnel in the machine operating group perform 1103A operations, IBM machine wiring and operations and key punching as required.

Operation tends toward open shop.

All personnel hired by ORO are given a two-month training assignment in the Computing Laboratory prior to an assignment to a research task. The two-month training is divided as follows: one month devoted to 1103A characteristics and general programming techniques, one month development of a practical problem. Operators, engineers and technicians are supplied as required by Remington Rand.

Southern Methodist

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	2
Analysts	6	10
Clerks	3	4
Engineers	1	

Operation tends toward open shop.

Methods of training used includes credit courses in the university and on-the-job training.

U of Minn

Staff consists of:

- One department head
- One research fellow
- One junior engineer (maintenance)
- One secretary
- Seven research assistants (part time)
- Three maintenance technicians (part time).

With this staff 12 to 14 hours of computing time is available daily, when needed.

Clients are urged to do as much programming, coding, and operating as possible with all non-routine problems. Any routine or standardized problem, such as matrix inversion, is done by the staff (if a program is available for the problem).

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

WSMR IRM

Average error-free running period 4 Hours
Good time 60 Hours/Week (Average)
Attempted to run time 70 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period 1 Jan 59 to 31 Mar 60
Passed Customer Acceptance Test 17 Feb 58
Time is not available for rent to outside organizations.

Most difficulties account for the difference between good time and attempted to run time were caused by mechanical malfunction of Uniservos. Until very recently it was necessary to write programs utilizing all available Uniservos and a malfunction of any one would result in an attempt to run resulting in failure. Recently the number of Uniservos have been increased to 10 which will tend to eliminate this source of difficulty.

Holloman AFB

Good time 57.34 Hours/Week (Average)
Attempted to run time 60 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period 1 Jan 60 to 30 Apr 60
Passed Customer Acceptance Test (1) Mar 57 (2)Nov 57
Time is available for rent to qualified outside organizations.

W-P AFB

Good time 101.58 Hours/Week (Average)
Attempted to run time 103.66 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.979
Above figures based on period 1 Apr 60 to 1 Oct 60
Passed Customer Acceptance Test Jun 58
Time is available for rent to qualified outside organizations.

NASA Lewis

Good time 77.5 Hours/Week (Average)
Attempted to run time 93.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.834
Above figures based on period 1 Jan 59 to 1 Jan 60
Passed Customer Acceptance Test Sep 55
Time is not available for rent to outside organizations.

Lockheed

Average error-free running period 30 Hours
Good time 272.4 Hours/Week (Average)
Attempted to run time 280.2 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.966
Above figures based on period 1 Feb 60 to 27 Mar 60
Passed Customer Acceptance Test (1) Apr 58 (2) Jul 58
Time is available for rent to outside organizations.

The above figures are based on a two computer system.

Johns Hopkins APL

Average error-free running period 19.6 Hours
Operating ratio 0.98
Above figures based on period 20 May 57 to present
Passed Customer Acceptance Test 20 May 57
Time is available for rent to qualified outside organizations.

Johns Hopkins ORO

Good time 113.7 Hours/Week (Average)
Attempted to run time 115.7 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.982
Above figures based on period 1 Apr 60 to Jul 60
Passed Customer Acceptance Test Sep 57
Time is available for rent to qualified outside organizations.

Southern Methodist

Good time 45 Hours/Week (Average)
Attempted to run time 45.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.99
Above figures based on period 1 Jul 59 to 1 Jul 60
Time is available for rent to qualified outside organizations.

U of Minn

Average error-free running period 18.67 Hours
Good time 51.10 Hours/Week (Average)
Attempted to run time 55.30 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.924
Above figures based on period 1 Jul 59 to 30 Jun 60
Passed Customer Acceptance Test Jun 58
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

WSMR IRM

The water cooled design of this equipment virtually eliminates difficulties associated with refrigeration and air conditioning. As a matter of actual fact the computer room is cooler than is maintained in most offices.

Magnetic tapes are stored in wall cabinets within the computer room. The number required is small as compared with most installations of this type. Normal building conditioning provides adequate protection from humidity temperature, etc. Security against loss of operating ability due to fire is accomplished by providing duplicate tapes to other installations under this command such that in case 1 tape is damaged it could be replaced within a matter of an hour or two and by duplicate programming of problems on other machines in the neighborhood, such as the IBM 704 located at DRD-N and the IBM 704 Computer operated by the Flight Simulation Laboratory at WSMR. For the particular applications involved at WSMR loss of data tapes is not as critical as the loss of programming tapes. No special care is taken to insure against loss of data tapes.

Integrated Range Mission of White Sands Missile Range operates two computing facilities. The 1103A reported in this questionnaire and an IBM 704 Computer physically located at Holloman Air Force Base are reported on separately. Both computers are used for the same type of activity, namely the conversion of raw range flight test measurements to engineering forms of data. It is anticipated that about January 1962 it will become necessary to replace the existing 1103A Computer with a solid state computer having much greater internal speed and greater capacity. Machines of the CDC 1604, IBM 7090, Philco 2000, etc. type are being considered. A feasibility study is under way to ascertain whether at that time it will be feasible to replace the 704 Computer at Holloman with a high speed data link and utilize the one high speed computing facility in place of the two now in operation.

It is planned to replace the card-to-tape converter, the tape-to-card converter, and the high speed printer with a USS 80 Computer. In so doing the overall operation will be speeded up, economy in floor space will be achieved, and an increase computing capacity will be provided while at the same time the cost of operation will be reduced.

Eglin AFB

Additional equipment can be connected by controlled bits on a selector board (colloquially designated OR board).

NASA Lewis

Simultaneous input, output, and computing on problems. Concurrent operation on two separate problems, each with its own input, output, and computer.

The machine, its peripheral equipment and its programming aids are tailored to do data reduction in the most efficient manner, with the lowest level programmers possible.

Lockheed

A library system for reserved tapes is maintained. No particular protection for tapes due to durability of metal tapes. Fireproof storage media is currently undergoing evaluation.

The 1103AF system is composed of the following components: 2 Univac Scientific 1103AF Computers each with floating point, variable block, 8,192 words of core storage and 16,384 words of drum storage. There are two Remington Rand 600 lines/min printers, and one Remington Rand Card-to-Tape Converter.

Johns Hopkins ORO

Outstanding features are considerable memory capacity, high internal operating speed, and great versatility in transferring information to and from external equipment.

U of Minn

Electronic Associates DATALINK provides 6 channels of conversion from analog to digital (13 bits/word) and 4 channels of conversion from digital to analog. The DATALINK connects the 1103 with a REAC (Reeves Electronic Analog Computer) containing two computer cabinets (20 amplifiers in each) and a cabinet of four servos.

The 1103 has been modified to include two special instructions for work with polynomials, an instruction for transmission of a word from the left half of the accumulator, and an interrupt feature to increase system efficiency when external equipment is used.

FUTURE PLANS

Holloman AFB

An output platform is being designed which allows an automatic recording, i.e. without computer control, of all real-time computer outputs and a digital and analog display of real-time computer outputs.

W-P AFB

The 1103A will be phased out by June 1961 due to the installation of the IBM 7090 in November 1960.

NASA Lewis

Additional tape handlers, floating-point arithmetic hardware, high-speed line printer, compiler, and high-speed plotting are planned.

Lockheed

LMSD is in the process of converting all 1103AF work to IBM 7090 and CDC 1604 Systems. Both 1103AF's will be released.

Johns Hopkins APL

IBM 7090 Computer System with 1401 C3 planned for installation.

Southern Methodist

On line printer for 1103.

Addition of Solid State 90 with six tapes, computer and full complement of Remington Rand tabulation equipment.

INSTALLATIONS

White Sands Missile Range
Integrated Range Mission-DRD
White Sands Missile Range, New Mexico

3208th Test Group (TF)
Computer Operations
APGC (PGVMC)
Eglin Air Force Base, Florida

Air Force Missile Development Center
Analysis and Computation Division (MDWC)
Holloman Air Force Base, New Mexico

Wright Air Development Division
Digital Computation Branch (WWDCD)
Wright-Patterson Air Force Base, Ohio

National Aeronautics & Space Administration
Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Lockheed Missile and Space Division
Digital Computer Operations
Sunnyvale, California

Johns Hopkins University
Applied Physics Laboratory
8621 Georgia Avenue
Silver Spring, Maryland

Johns Hopkins University
Operations Research Office
6935 Arlington Road
Bethesda 14, Maryland

Southern Methodist
Computing Laboratory
Dallas 22, Texas

University of Minnesota
Numerical Analysis Center
Minneapolis 14, Minnesota

PRODUCTION RECORD

Number of Univac 1100 Series Systems (all models) delivered is 45.

UNIVAC 1105

Univac 1105 Computing System

MANUFACTURER

Remington Rand Univac Division
Sperry Rand Corporation

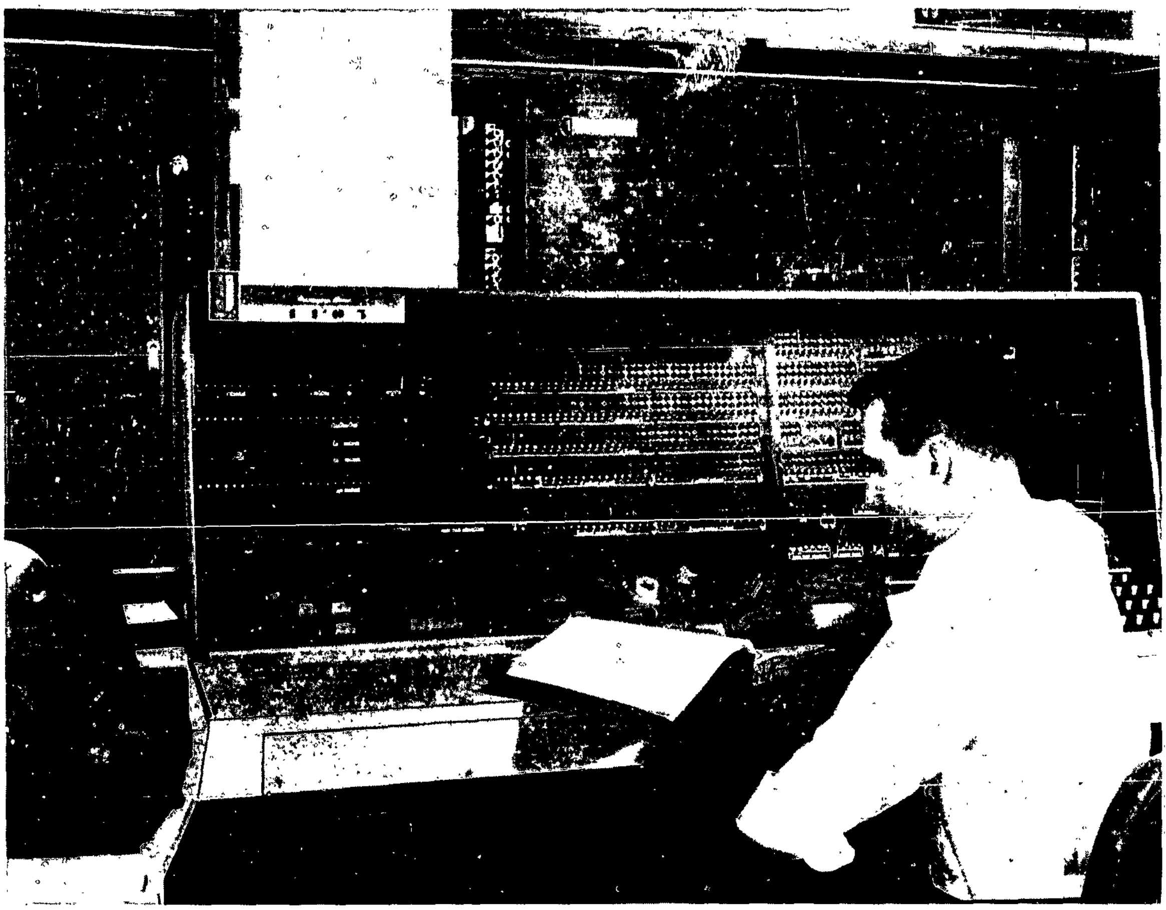


Photo by Remington Rand Univac

APPLICATIONS

Manufacturer

System is used for both scientific and commercial applications, for example, satellite tracking and trajectory calculations, linear programming, logictics, scheduling, inventory control, and census.

The Univac 1105 Computing System is a synchronous, large scale, high speed, general purpose, automatic data processing computing system. Programs of internally stored instructions, capable of self-modification, determine the sequence of operations. Internal storage is afforded by directly addressable magnetic cores and drums. The system is designed to use magnetic tape, punched cards, punched paper tape, electric typewriter, analog-to-digital and digital-to-analog converters, visual displays, plotters and real time instrumentation as input-output.

U. S. Air Force, Dayton AF Depot

Located at Dayton Air Force Depot, Wilmington Pike, Dayton, Ohio, the system is used for the following fields of application:

Stock Control and Distribution - Inventory Management

Method of controlling and distributing material by Air Material Command Supply Depots and AMA's to Air Force activities, maintenance contractors and other military services world-wide. The system provides a data processing technique which enables AMC to administer a timely, accurate and effective supply logistics system. It provides item accounting, including inventory position and various products for effective management of serviceable, reparable and excess material. By-products which are the basis for dollar accounting and Air Force assets management, inputs for requirements computation and other stock control purposes are provided.

Management and Control of Due-In-Assets

Recording of assets due in from contractual procurement, Department of Defense excesses or other Air Force activities. The depot having responsibility for a commodity class or specified weapons system utilizes this data system to administer a more timely and effective logictical support system. Item account-

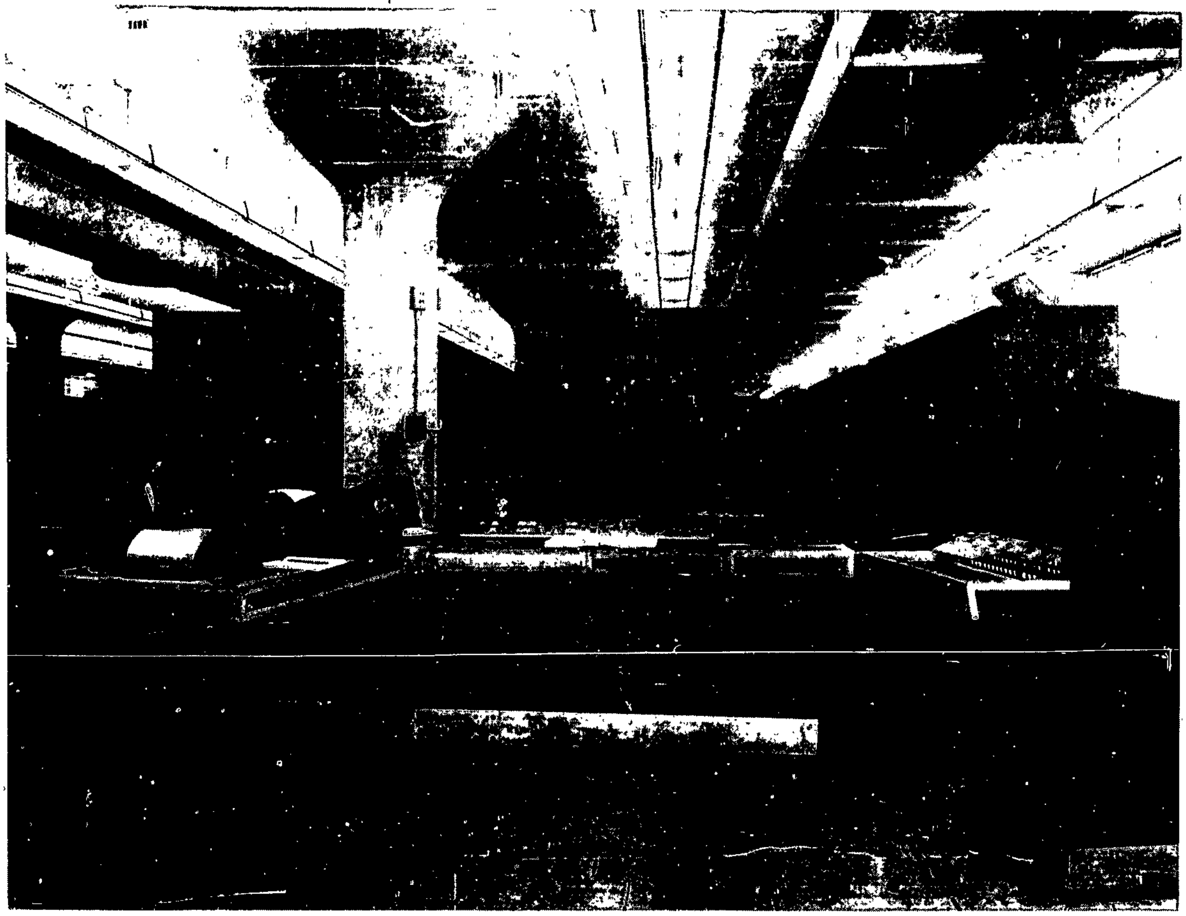
Photo by Remington Rand Univac

ing providing due-in status data for utilization in material distribution, requirements computation and buying programs, are included in this system.

Requirements Computation - Replacement Type Items
The purpose of this application is to design, develop, and implement a data flow and data processing system by which various types of replacement item data products, required at appropriate AMA/AFD, Hq AMC, and higher headquarters management levels may be periodically computed on an AF world-wide basis. The system as designed is to be capable of promptly reacting to changes in the many elements which affect AF requirements for items (e.g., program changes, authorization changes, support policy changes, funding limitations, etc.) is also to be compatible with the latest data handling and processing technological improvements. The system as presently implemented is designed to provide the following major types of replacement item requirements and related management data summarized by weapons/support system, funds program/project; program group, mission code, property class, AMA/AFD, or total AMC, as appropriate for the products involved. Data now output from the system are: time-phased projections of "gross" and "net" item requirements; procurement program and budget estimates item and/or dollar summaries of the above; contract termination and retention/disposal level data; consolidated asset and item information data summary products; item-dollar inventory segmentation and requirements support effectiveness data; and weapon and support systems.

Product Performance Analysis Airborne Armament and Electronic Items
A data processing system that will measure the weapon and/or commodity performance and meet the needs of the reliability and the product improvement and USAF Acturial programs; provide serviceability and reliability indicators, acturial life expectancies and failure pattern; and correlate configuration data, reliability, usage, failure and consumption data, and other historical data into a data system for the air vehicle.

Covers the system that will measure the weapon's performance and provide an early warning and ready reference master record of failure trends by system and component within the weapon system; provide maximum automatic analysis; provide for the weapon managers, serviceability and reliability indicators such as acturial usage data, service life factors, failure rate grpahs, economic life factors, and condemnation rates that are essential to product improvement, provisioning, and the computation of requirements, and evaluation of periodic inspection intervals.



Technology Center   Photo by Remington Rand Univac

The following applications are scheduled to be production runs in the near future.

IM/FSC Cataloging, Standardization and File Maintenance
This project is to develop a system which will establish, maintain and distribute Federal Catalog and related data applicable to all inventory manager items, including, but not limited to, the following: Federal, Catalog, EAM Detail and Trailor Cards, Stock Control Data Cards, Packaging and Transportation Data Cards, Interchangeability Record Cards, and Family Group Publication EAM Cards. The system will provide for the: initiation and distribution of stock list change, initiate suspense and follow-up on request for Federal stock number, notification of stock number assignment to Air Force contractors; publication of stock control data sections; cross-reference sections; transportation and packaging data sections; interchangeability and substitution data sections and possibly the identification section of AF stock list. Initially, the ADP systems utilizing outputs from this project for the updating of catalog data are restricted to: Inventory Manager Stock Control and Distribution Management and control of Due-in Assets, maintenance operating stock support; requirements computation for consumption-type items. Weapons systems control and distribution; and base support class stock control and distribution.

Master Material Support Record
This project will develop procedures to establish and maintain a master material Support Record that will provide a complete source-coded range of parts and materials with replacement rates required for all levels of repair support. This record will be developed from initial provisioning source-coded documents and up-dated based upon engineering changes, source code changes, stock list changes, changes to replacement factors derived from improved methods of computation, and changes to specialized repair activity material standards and contractual material requirement lists. The record will serve as a basis for initial SRA material standards and contractual MRL's and provide a means whereby the Inventory Manager can analyze these documents and establish an acceptable relationship between SRA and contractor material projections and the Master Material Support Record. This project will furnish source data for computation of the Buyers Guide for operations and maintenance parts and material.

Manpower Management (Personnel and Labor Accounting)
This project involves a recording of employee skills, abilities, education, training, experience and test scores as a basis for selecting out of five (5) best qualified personnel for a given position vacancy.

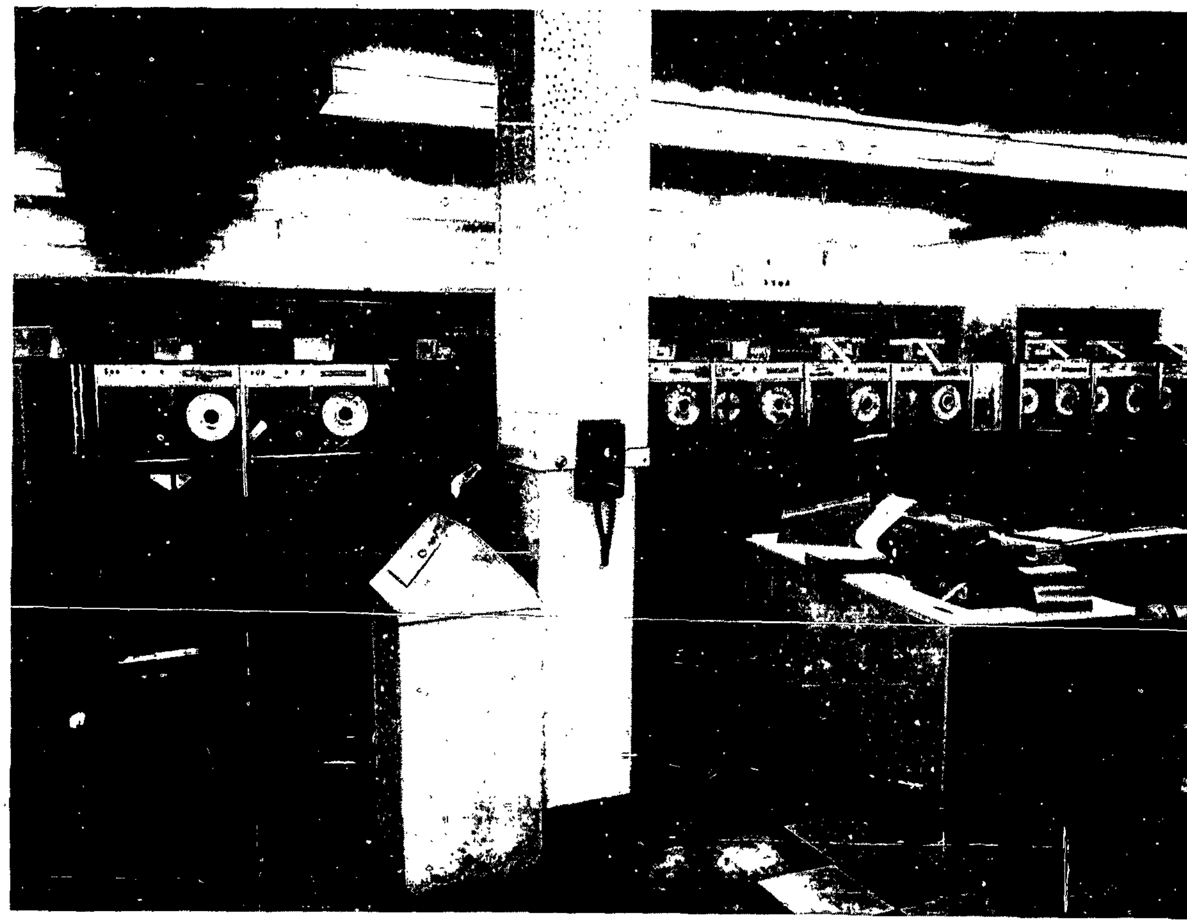


Photo by McClellan Air Force Base

Normally, this process will occur within a single depot, but for certain categories the entire command will serve as the selection base. Related products, required periodically, would be Reduction in Force Registers, data on skills losses (turn-over), skills-usage trends, and on inventory of skills levels as a basis for determining proper station assignment of new missions or functions.

Automation of Item Schedules for Procurement Documents

This project visualizes optional automation of the PR coordination cycle as a continuous flow from generation of a requirements to the subsequent automatic preparation of IFB/RFP schedules. Areas to be incorporated within the project include: the automatic grouping of items for procurement purposes, automatic initiation of funds, standardization of procurement data, precoordination of PR's, and automatic preparation of item schedules.

Civilian Personnel and Labor Accounting

The objective of this project is to permit machine preparation of the following in lieu of the present manual systems:

SF 50's Personnel Action; periodic pay increases; notification of automatic actions, i.e., age, retirement, service awards, detail expirations, annual performance evaluations; Unit Manning Document; all statistical reports; automatic print-out to indicate any condition reflected by statistics, requiring administrative action, i.e., sick leave, turnover, tardiness, unused annual leave, grade levels, job-shortage categories, etc.; classification survey schedules; rosters of all persons who have received training by specific courses and rosters of all training received (all courses) by specific individuals; skills rosters, for purposes of Merit Promotion Program, detailing employees, reassignment, training, recruitment, etc.; profiles for merit promotion program in rank order; print-out of entire service history of any employee for any reason needed; payrolls; and leave, bond, retirement records currently maintained manually.

USAF ROAMA Griffiss AFB, N. Y.

Located in Building No. 311, system is used for stock control and distribution, requirements computation, and Ground C&E Management.

USAF Sacramento Air Materiel Comd, McClellan AFB

Located at McClellan AFB, California, the system is used for weapons system inventory control and distribution and requirements computation.

Bureau of the Census

Located in Washington D.C., the system is used for statistical data processing for current statistical

Photo by University of North Carolina

surveys of population, trade, and industry, decennial censuses of population and housing, and other major periodic censuses involving editing and rearranging of input, sorting and merging of records, tallying, tabulating, and summarizing data, computing percentages, medians, means, weights, variances, etc. for data, and arranging and preparing tables, listings, labels, etc. for high speed printer.

Bureau of the Census - Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

Same as for Bureau of Census in Washington, D. C.

Bureau of Census - University of North Carolina, Chapel Hill, North Carolina

Same as Bureau of Census in Washington, D. C.

University of North Carolina

Located in Phillips Hall, University of North Carolina, Chapel Hill, North Carolina, the system is used for data processing for the Bureau of the Census, Washington, D. C., scientific research, statistical applications, automatic programming research, and teaching.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36
Binary digits/instruction	36
Instructions per word	1
Instructions decoded	41 fixed point and 9 floating point
Arithmetic system	Fixed and floating point

1 bit sign, 35 bit number

1 bit sign, 8 bit characteristic, 27 bit mantissa

Instruction type Two address

6 bit operation code and two 15-bit operand addresses

Number range Fixed point $2^{35} - 1 \geq X \geq 0$

Floating point $2^{127} > X \geq 2^{-129}$ and 0

Instruction word format

Operation Code		1st Address		2nd Address	
35	30	29	15	14	0

Automatic built-in subroutines include automatic interrupt feature, external function instructions, repeat instruction, floating point polynomial multiply and inner product instructions.

Automatic coding includes UNICODE algebraic compiler, USE compiler, IT algebraic compiler, GAT compiler, AIMACO business compiler, and 650 Simulator.

Registers include a 72 bit directly addressable accumulator, a 36 bit directly addressable multiplier-quotient register, a 36 bit input-output register, and an 8 bit input/output register.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	32-60	12-28
Mult	116-410	92-386
Div	482-490	466-474

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	No. of Binary/Digits	Access Microsec
Magnetic Core	4,096	147,456	8
	8,192	294,912	
	12,288	442,368	
Magnetic Drum	16,384	589,824	17,000
	32,768	1,179,648	

Magnetic Tape

No. of units that can be connected	24 Units
No. of char/linear inch of tape	250 Char/inch
Channels or tracks on the tape	8 Tracks/tape
Blank tape separating each record	1.2 or 2.4 Inches
Tape speed	100 Inches/sec
Transfer rate	25,000 Char/sec
Start time	3.5 Millisec
Stop time	3.5 Millisec
Average time for experienced operator to change reel of tape	10-15 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Mylar or metallic

USAF DAFD

Media	No. of Words	No. of Digits/Word	Access Microsec
Magnetic Core	12,288	12 Octal	8
Magnetic Drum	32,768	12 Octal	17,000
Magnetic Tapes	Up to 720,000	12 Octal	50,000 (120 words)

(95% free for computation)

USAF ROAMA

Media	No. of Words	No. of Binary/Dig	Access Microsec
Magnetic Core 0	4,096	36	8
Magnetic Core 1	4,096	36	8
Magnetic Core 2	4,096	36	8
Magnetic Drum	32,768	36	17,000
Magnetic Tape	Unlimited		

USAF SAMC

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	12,288	73,748	12
Magnetic Drum	32,768	196,608	17,000
Magnetic Tape			
Census Washington; Census-Armour; Census U of NC			
Magnetic Core	8,192	49,152	6
Magnetic Drum	16,384	98,304	2-34,000

U of NC

Media	No. of Words	Access Microsec
Magnetic Cores (2)	8,192	8
Magnetic Drum (Double)	32,768	0-34,000

17 buffered tape units in the system.

INPUT

Manufacturer

Media	Speed
Cards	120 cards/min
Magnetic Tape	25,000 char/sec
Paper Tape	200 char/sec

Magnetic tape block length is variable. Tape may be read backward. Six bit characters are used on both paper and magnetic tape. Paper tape is seven channel tape. 80 column cards are used.

USAF DAFD

Media	Speed
Punch Cards	120 cards/min
Punch Paper Tapes	17 words/sec
Magnetic Tape	3,300 words/sec

ROAMA

Photoelectric Reader	12,000 char/min
Magnetic Tape	100 inches/sec

Magnetic tape reading any density.

USAF SAMC

Magnetic Tape	300 microsec/word
Paper Tape	200 frames/sec

There are 20 magnetic tape unit.

Census Washington, Census-Armour, Census-U of NC

Magnetic Tape (2 independent channels)	20,000 char/sec
Paper Tape (Ferranti)	200 char/sec
Keyboard Insert	Manual

Two independent channels of magnetic tape. Magnetic tape is utilized in the buffered free-run mode.

Census-U of NC has 120 cards/min reader.

U of NC

Cards	120 cards/min
Paper Tape	230 frames/sec
Magnetic Tape	100 in/sec

128 lines per inch - low density
200 lines per inch - high density

OUTPUT

Manufacturer

Media	Speed
Cards	120 cards/min
Paper Tape	60 bit char/sec
Typewriter (Flexowriter)	10 char/sec
High Speed Printer	600 lines/min
	120 char/line

Cathode ray tube (visual display) read-out may be added. 80 column cards are used. Six bit characters, seven channel paper tape. The high speed printer is operated off-line. It can be adapted for plotting.

USAF DAFD

Punch Cards	120 cards/min
Paper Tape	5 words/sec
Magnetic Tape	3,300 words/sec
Typewriter	10 char/sec

ROAMA

Magnetic Tape	100 in/sec
High Speed Paper Tape Punch	3,600 char/min

Magnetic tape writing at a density of 128 or 200 lines/inch.

USAF SAMC

Magnetic Tape	300 microsec/word
Paper Tape	60 frames/sec
Typewriter	100 words/min

Census Washington, Census-Armour, Census-U of NC

Magnetic Tape	20,000 char/sec
Paper Tape (Teletype)	60 char/sec
Monitoring Typewriter (Flexowriter)	10 char/sec

U of NC

Cards	120 cards/min
Paper Tape	60 frames/sec
Magnetic Tape	100 in/sec
Typewriter	10 char/sec

Cards are not in use.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity
Tubes	
7AK7	3,261
5963	3,066
6AN5	947
5725	252
All others	767
Diodes	
HD2261	12,789
1N143	2,112
1N117	1,208
All others	306
Transistors	
2N414	724
T1677	288
2N315	136
Magnetic Cores	
S-4	294,912
All others	9,138

A total of 21 tube types are used.
Eleven types of diodes are used.
Ten types of transistors are used.
Three types of cores are used.

Components for Uniservo II (Model 102), a 3rd Core Bank, and floating point circuiting are not included in the above figures, but are listed below-

3rd Core Bank

Vacuum Tubes	Diodes	Cores	Transistors
8 types- total 471	3 types- total 2,267	147,456 Type S-4	None

Floating Point

Vacuum Tubes	Diodes	Cores	Transistors
3 types- total 244	5 types- total 678	None	None

Uniservo II

Vacuum Tubes	Diodes	Cores	Transistors
7 types- total 43	4 types- total 9	None	None

CHECKING FEATURES

Manufacturer

Checking features include overflow, timing, in-out-put, illegal operation codes and addresses, and safety interlocks.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, entire computer system	160 Kw, 175 KVA, 0.9 pf
Room size	49 ft x 64 ft x 10 ft
Floor loading	47 lbs/sq ft
Weight, computer	35 Tons

Air conditioning unit for cooling input water should be at least 35 tons capacity.

USAF DAFD

Floor loading	size of plenum 22 ft x 50 ft x 13 ft
Weight, computer	63,753 lbs

Computer is installed in a warehouse type building with plywood temporary constructed walls. The lighting, floor and power supply is that of a typical office.

The Univac 1105 Computer System is operated from a 208V, 3 phase, 4 wire, 60 cps. supply. Isolation from line transients is achieved by use of a motor-alternator set and 70 KVA stabeline supplied with the equipment. The motor-alternator, together with its controls, is located in a separate room. The connection to the computer is below the floor. The maintenance area is supplied with 115V, 15 amp. single place outlets at each bench and three phase, 208V, 15 amp, four wire, 60 cps. service for the chassis test unit. The line-to-line voltage is 208V ± 10% during normal operation. All three line-to-line voltages are balanced to within 2% during normal operations. The basic equipment load consists of a 100 hp motor, 3 hp blower motors, a 3/4 hp drum motor, and 70 KVA stabeline. The 100 hp motor, which drives a 75 KVA alternator, is started with no load and has a reduced voltage starter control.

The floor space for the 1105 computer is approximately 3,752 sq ft. The power, refrigeration and equipment room uses approximately 2,450 sq ft.

The cooling system requires 50°F cooling water and a room temperature of approximately 80°F maximum at 60% relative humidity or lower. This system consists of three fans cabinets which cool the room air and a plenum which distributes the cooled air to the electronic computer. In addition to the computer, each uniservo requires 3.5 gallons of water per minute. Requirements and data for the air cooling system are as follows:

Cooling water temperature (Input) 50°F max.
Cooling water pressure (Input) 60 lbs/sq in, gage
Water flow through entire system 168 gal/min, max
Exhaust air temperature from computer 74°F-80°F.
Maximum allowable relative humidity 60°.
Blower capacity 12,750 cu ft/min

ROAMA

Power, computer	170 Kw	170 KVA
Power, air condi	40.4 Kw	40.7 KVA
Volume, computer		41,000 cu ft
Volume, air conditioner		42.0 cu ft
Area, computer		4,100 sq ft
Area, air conditioner		84 sq ft
Floor loading		200 lbs/sq ft
		4,800 lbs concen max
Capacity, air conditioner		75 Tons
Weight, computer		63,253 lbs
Weight, air conditioner		8,000 lbs

208, 3 phase, 4 wires, 60 cps for computer. 220V, 3 phase, 4 wire for air conditioner. Constructed new permanent building designed specifically for the computer.

USAF SAMC

Power, computer	146 Kw	170 KVA	0.86 pf
Power, air condi	160 Kw	200 KVA	0.86 pf
Volume, computer		3.246 cu ft	
Volume, air conditioner		846 cu ft	
Area, computer		3.600 sq ft	
Area, air conditioner		1,881 sq ft	
Room size, computer		60 ft x 60 ft	
Room size. air conditioner		42 ft x 65 ft	
Floor loading		150 lbs/sq ft	
		700 lbs concen max	
Weight, computer		57,089 lbs	
Weight, air conditioner		75,000 lbs	

Floor is cement and was trenched for cables and chilled water pipes. Acoustical tile was applied to a false ceiling and walls of the room. It was necessary to increase the power to meet the demands of the UFC and 1105. Site preparation for both systems was done simultaneously. Air conditioning was increased and necessary duct work installed.

Census Washington

Power, computer	150 Kw	170 KVA	0.9 pf
Volume, computer		30,000 cu ft	
Area, computer		3,000 sq ft	
Room size		100 ft x 30 ft x 10 ft	
Floor loading		50 lbs/sq ft	
Weight, computer		60,450 lbs, each	

Alteration of area from previously subdivided sections into the large enclosed area 100x60. Provision of chilled water lines, power conduits and space, air conditioning equipment and air ducts. Alteration of lighting fixtures. Area enclosed in fire wall construction. Air conditioner part of integrated system.

Census - Armour

Power, air cond	25 Kw	29 KVA
Room size, computer		50 ft x 60 ft x 10 ft

Site specifications included on plans for newly constructed building.

Census - U of NC

Power, air condition	29 KVA	25 Kw
Room size, computer		40 ft x 75 ft x 10 ft

Site specifications included in plans for newly constructed building.

U of NC

Power, computer 110 Kw	170 KVA 0.9 pf inductive
Power, air cond	100 KVA
Volume, computer	17,000 cu ft
Area, computer	2,816 sq ft
Area, air conditioner	600 sq ft
Floor loading	70 lbs/sq ft
Capacity, air conditioner	75 Tons
Weight, computer	35 Tons

Computer was installed in the basement of a new building and the space was specifically constructed for this purpose, i.e. with a recessed floor and plenum type of installation.

PRODUCTION RECORD

Manufacturer

Number produced to date 45 incl. all 1100 models

COST, PRICE AND RENTAL RATES

Manufacturer

	Cost	Monthly Rental
Basic system, consisting of 8,192 words Magnetic Core, 16,384 words Magnetic Drum, Central Processor, Peripheral Control, and 16 UNISERVO II	$1,932,000	$33,060
Additional Equipment		
4,096 Magnetic Core	$195,000	$4,500
16,384 Magnetic Drum	60,000	1,500
Floating Point	65,000	1,545
Uniservo II	20,000	450
Card In-Output	55,000	1,310
High Speed Printer	185,000	3,300

Printer is off-line, 80 column card unit.

Training courses and manuals are provided for all computers whether purchased or rented.

USAF DAFD

	Cost	Monthly Rental
Model 1105 Univac Computer (Basic) includes:	$1,612,000	$33,060

Magnetic Core Storage (8,192 words)
Magnetic Drum Storage (16,384 words)
Two Section Tape Input/Output Buffer; 120 words/Section
Variable Block Length Feature
Magnetic Tape Control (Accommodates up to 24 magnetic tape units)
Power Supply
Desk Console with Monitorial Oscilloscope
Arithmetic Section
Main Control Section
Air Conditioning Section (Requires Customer-Furnished 50° Water)

The following Directly Connected Input/Output Units:
1-Photo-electric Punched Paper Tape Reader
1-High Speed Paper Tape Punch
1-Monitoring Electric Typewriter

Additional Equipment:

	Cost	Monthly Rental
1 - Additional Bank of 4,096 Word Core Storage	$ 195,000	$ 4,500
1 - Additional Magnetic Drum Storage 16,384 Words	60,000	1,500
20 - Uniservo II Magnetic Tape Units	400,000	9,000
5 - Unityper II	22,500	450
1 - Univac Verifier (Non-printing Type)	15,000	250
1 - Card to Metallic Tape Converter, 80 column	143,300	2,540
1 - High Speed Printer - Off-Line (Water Cooled) (600 lines per minute)	185,000	3,300
1 - Metallic Tape to Card Converter - 80 column	Quoted on request	2,385
	$1,020,000	$23,925

Total approx. Selling Price $2,632,800 (Basic and Additional Equipment)

Total monthly rental $ 56,985

Maintenance/Service Contracting:

Remington Rand will keep the equipment in good operating condition, all costs of maintenance will be borne by the contractor unless the required maintenance is due to the fault or negligence of the installation.

Remington Rand shall have its personnel in attendance during all periods of operation unless other mutually agreeable arrangements have been made. The maintenance personnel during a principal period of maintenance which is any eight consecutive hours per day plus an official meal period not to exceed one hour per day, Monday thru Friday, excluding holidays. By giving seven days notice to the contractor, additional maintenance service periods of time other than the designated Principal Period of maintenance can be arranged.

All preventive (scheduled) maintenance will be performed at a time other than during working hours, unless otherwise arranged.

The installation will be charged for maintenance whenever (1) maintenance personnel are required outside the principal period of maintenance, and the total operational use time on the main f[illegible] (or central computer) during the Principal Period of maintenance, is less than 176 hours during a calendar month. However, there will be no extra maintenance charge for periods of preventive or remedial maintenance. Extra maintenance will be at the rate of twelve dollars per man hour computed to the nearest one-half hour.

ROAMA

Central Computer	$33,060
Addition Bank Word Core Storage	4,500
Additional Magnetic Drum Storage	1,500
Twenty Uniservos	9,000
Bi-Directional Converter	4,275
High Speed Printer	3,300

USAF SAMC

1105 Basic, Magnetic Core Storage, Magnetic Drum Storage, Uniservo II, $48,060 per month.
Flexowriter $110 per month.
Maintenance is included in rental price.

Census Washington

2 Univac 1105 Computers, 18 tape units each, site preparation and installation, spare chassis, initial parts inventory, test equipment $3,080,000 total.

1 Unityper Mod II, 3 Flexowriters, 1 high speed printer buffered with extra print head $258,000.

Card-to-tape converter $2,600 per month.

Own maintenance is performed.

Census - Armour

Equipment owned by University but shared with Bureau of the Census on pro rata cost basis. Equipment includes 1 Univac 1105 Computer with 17 tape units, 1 high-speed printer, 1 unityper, 2 Flexowriters. Census share of total installation current cost and equipment amortization (for 90 to 100 hours per week of computer time) equals $320,000 yr.

Census - U of NC

Equipment owned by University but shared with Bureau of the Census on pro rata cost basis. Equipment includes 1 Univac 1105 Computer with 17 tape units, 1 high-speed printer, 1 unityper, 2 Flexowriters. Census share of total installation current cost and equipment amortization (for 90 to 100 hours per week of computer time) equals $320,000 yr.

U of NC

The system was purchased for $2,450,000.

The Univac 1105 Data Automation System at the University of North Carolina is made up of the following:

1 Univac Scientific Computer Model 1103A consisting of 4,096 words of core storage, 16,384 words of drum storage, photo-electric paper tape reader, high speed paper tape punch, on line Flexowriter, supervisory control console, motor alternator set, plenum type construction, air conditioning fan bay.
2 120 word core buffer units
1 Additional bank of 4,096 word core memory
1 Variable block feature for magnetic tape recording
17 Uniservo II, high density tape units
1 Off Line High Speed Printer
1 Unityper II
1 Additional Drum, 16,384 word capacity
1 1105 operational test unit
1 Complement of 1105 replacement chassis
1 Floating Point Feature
4 Off Line Flexowriters
1 Spare Photo Electric Paper Tape Reader
1 Spare High Speed Paper Tape Punch

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	4	5	6
Analysts	7	7	7
Program & Coders	15	16	17
Clerks	2	2 1/2	3
Librarians	1/2	1/2	1/2
Operators	3	4	5
Engineers	3	4	5
Technicians	3	5	7
In-Output Oper	1 1/2	2	2 1/2

Free courses are provided to the customer to instruct its personnel in programming for and maintenance of the computer.

USAF DAFD

	One 8-Hour Shift Used	Recommended
Supervisors	4	5
Analysts	17	20
Programmers	31	44
Clerks	4	2
Librarians	2	2
Operators		4

4 Engineers and 3 Technicians used on three 8-hour shifts.

The Dayton AF Depot currently has two large scale electronic computers in operation viz., Univac I and Model 1105. Univac I is scheduled to be discontinued in the near future. At the present time there are twenty-one (21) civilians and five (5) airmen assigned to the operation of these computers.

3 Supervisors
  1 Unit Chief
  1 Supervisory Tape Librarian
  1 Peripheral Equipment Supervisor
10 Civilian computer operators
  6 Operate both Univac I and 1105
  4 Operate only Univac I
5 Airmen computer operators
  1 Operates both Univac I and 1105
  3 Operate only Univac I
  1 Operates only peripheral equipment
2 Civilian tape librarians
2 Civilian clerks
4 Civilian peripheral equipment operators

A one eight-hour shift is scheduled with available time on two other shifts depending upon the nature of the work and its priority.

Methods of training used includes training by the equipment manufacturer, Remington Rand Corp, and on-the-job training.

ROAMA

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Librarians	1	1
Operators	3	3
In-Output Oper	3	3

Methods of training used includes manufacturer's courses.

USAF SAMC

	One 8-Hour Shift Used	Recom	Three 8-Hour Shifts Used	Recomm
Supervisors			4	4
Analysts	52	52		
Programmers	63	63		
Librarians			3	4
Operators			12	12

Personnel support the 650, UFC and 1105 systems.

Operation tends toward closed shop.

Manufacturer training and on-the-job training is utilized.

Census Washington

	Three 8-Hour Shifts
Supervisors	3
Analysts, Programmers & Coders	40
Clerks	8
Librarians	5
Operators	12
Engineers	2
Technicians	15
In-Output Oper	8
Tape Handlers	20
Other	4

Most programmers shown are customer employees; tape handlers are customer employees.

Operation tends toward open shop.

Training Branch conducts formal classroom sessions for programmers, operators (followed by on-the-job training) executive orientation, brush-up seminars. Classroom and on-the-job training also conducted for engineers and technicians.

Census - Armour

	Three 8-Hour Shifts
Supervisors	3
Analysts, Programmers & Coders	20
Clerks	2
Operators	6
Engineers	1
Technicians	10
In-Output Oper	2
Tape Handlers	5

Programmers shown are customer employees, tape handlers are customer employees; all others are University employees.

Operation tends toward open shop.

Training Branch conducts formal classroom sessions for programmers, operators (followed by on-the-job training) executive orientation, brush-up seminars. Classroom and on-the-job training also conducted for engineers and technicians.

Census - U of NC

	Three 8-Hour Shifts
Supervisors	3
Analysts, Programmers & Coders	20
Clerks	2
Operators	6
Engineers	1
Technicians	10
In-Output Oper	2
Tape Handlers	5

Programmers shown are customer employees, tape handlers are customer employees; all others are University employees.

Operation tends toward open shop.

Training Branch conducts formal classroom sessions for programmers, operators (followed by on-the-job training) executive orientation, brush-up seminars. Classroom and on-the-job training also conducted for engineers and technicians.

U of NC

	One 8-Hour Shift	Three 8-Hour Shifts
Supervisors	1	
Analysts	2	
Programmers	6	
Clerks	1	
Librarians	1	
Operators		4
Engineers		5
Technicians		8
In-Output Oper		3
Tape Handlers		4

The 8 hour shift figures represent University requirements only. The three 8 hour shifts requirements represent University and Bureau of the Census personnel needs since the University supplies all personnel in these particular categories.

Operation tends toward open shop.

Methods of training used includes training course conducted by the Bureau of the Census for Computer Operators, vourses conducted by the Computation Center for training maintenance personnel (This is not an accredited University course.), on-the-job training, accredited University courses and Graduate Seminars on Computer Usage and Programming. (These courses at present are oriented towards scientific applications.), and special short courses on programming (Not accredited University courses.).

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Regularly scheduled preventive maintenance procedures designed to detect failing components before errors occur.

USAF DAFD

Good time 60 Hours/Week (Average)
Attempted to run time 71 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.8 to 1.0
Above figures based on period from May 60 to Jul 60
Passed Customer Acceptance Test 30 Apr 60
Time is not available for rent to outside organizations.

USAF SAMC

Good time 98 Hours/Week (Average)
Attempted to run time 100 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on Mar and Apr 60
Passed Customer Acceptance Test 30 Apr 60
Time is not available for rent to outside organizations.

Good time includes Set-up time. The 2 hours lost time is unscheduled maintenance.

Census Washington

Good time (each machine) 126 Hours/Week (Average) includes lost time from non-machine causes)
Attempted to run time 136 Hours/Week (Average) (each machine; excludes scheduled maintenance)
Operating ratio (Good/Attempted to run time) 0.927
Above figures based on period 3 Apr 60 to 23 Apr 60
Passed Customer Acceptance Test Feb 59 and Jun 59
Time is not available for rent to outside organizations.

Census - Armour

Good time 85 Hours/Week (Average)
Attempted to run time 101 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period 28 Feb 60 to 1 May 60
Passed Customer Acceptance Test Jul 59
Time is not available for rent to outside organizations.

Good time includes lost time from non-machine causes. Attempted to run time excludes scheduled maintenance.

Census - U of NC

Good time 85 Hours/Week (Average)
Attempted to run time 101 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period 28 Feb 60 to 1 May 60
Passed Customer Acceptance Test Jul 59
Time is not available for rent to outside organizations.

Good time includes lost time from non-machine causes. Attempted to run time excludes scheduled maintenance.

U of NC

Good time 107.4 Hours/Week (Average)
Attempted to run time 122 Hours/Week (Average)
Operating Ratio (Good/Attempted to run time) 0.88
Above figures based on period 1 Jul 60 to 1 Oct 60
Passed Customer Acceptance Test 22 Aug 59
Time is available for rent to qualified outside organizations. Approximately 15 hours per week is available for outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features are interrupt feature, simultaneous read-write-compute, two address logic, 2 input-output registers for a large variety of on-line equipment, and repeat command. A unique system advantage is continuous input format capability on magnetic tape.

Special recommended procedures for magnetic tape labelling, storing, shipping, and protection from humidity, temperature, electrical, fire, or other damage are described in the Users Guide for Care and Preservation of Metallic Tape.

USAF DAFD

The 1105 Univac Computer is specifically designed for applications requiring great programming versatility, high operating speed, and large storage capacity. Maximum use of the high speed inherent in this computer is permitted by the unusual logical design and its unique Program Interrupt feature. In addition to performing large scale calculations, the system is adaptable to a wide variety of applications including simulation and control in real time.

Programs of internally stored instructions, capable of self-modification, determine the sequence of operations. Thus, the computing system is fully automatic. Its high speed results from parallel mode operation whereby all digits of a number are operated upon simultaneously.

Magnetic tapes are stored in a specially constructed concrete block vault and lined with copper screened wire to avoid any magnetic disturbance. Atmospheric conditions are 70°F and 50% R.H. Approximately 7,336 tapes are stored in cabinets elevated from the floor. Tape management is under the supervision of the tape librarian.

Peripheral Equipment - Space required is approximately 1,525 sq ft for the following equipment:

- Card-to-Tape Converter
- Tape-to-Card Converter
- High Speed Printer

The above components have an independent chilled water system and require 220 volts, single phase 60 cycle current.

USAF SAMC

The 1105's two bi-directional tape buffers, twenty Uniservo tape units and "interrupt" feature facilitate efficient simultaneous input, output and computation functions. The automatic programming in use on the 1105 provides for optimum use of its data processing capabilities.

Census Washington, Census-Armour, Census U of NC

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include fire wall construction; metallic containers for magnetic tape, fire fighting organization and training, control system for defective and damaged tapes, and standardization of tape reel lengths and markings.

FUTURE PLANS

USAF SAMC

SMAMA will acquire another 1105 in FY61 to support an advanced weapon system.

U of NC

Proposed new components include a locally designed and constructed 400 card/min reader and a programmer controlled clock and stop watch.

INSTALLATIONS

U. S. Air Force Dayton AF Depot
Wilmington Pike
Dayton, Ohio

U. S. Air Force ROAMA
Griffiss Air Force Base, New York

U. S. A. F. Sacramento Air Materiel Command
Data Systems Division, Comptroller
McClellan Air Force Base, California

Bureau of the Census
Washington 25, D. C.

Armour Research Foundation of Illinois Institute of Technology
Chicago, Illinois

Bureau of the Census
University of North Carolina
Chapel Hill, North Carolina

University of North Carolina
Computation Center
P. O. Box 929
Chapel Hill, North Carolina

The Prudential Insurance Company of America
Post Office Drawer 594
Newark 1, New Jersey

UNIVAC 1107

UNIVAC Thin Film Memory Computer 1107

MANUFACTURER

Sperry Rand Corporation
Remington Rand Univac Division

Photo by Remington Rand Univac Division, Sperry Rand Corporation

APPLICATIONS

Manufacturer

Basically, the UNIVAC 1107 is an advanced solid state data processing system designed and developed to provide reliable solutions to complex problems. This computer system is well suited to off-line, on-line and real-time problems in commercial, scientific, and military applications. With a versatile input-output section and a larger internal memory backed by a powerful instruction repertoire, the UNIVAC 1107 has capabilities not found in former systems.

The 1107 can efficiently and economically handle a wide range of applications, such as tactical data systems, command and control systems, digital communication and switching systems, data reduction and analysis, logistics, scientific computation, traffic control, reservation systems, computational analysis, inventory and scheduling systems, intelligence systems, systems simulation, missile and satellite dynamics, and process control.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36
Binary digits/instruction	36
Instructions/word	1
Instructions decoded	114
Arithmetic system	Fixed and floating point

Partial and multiple arithmetic may be performed. In partial arithmetic any 1/2, 1/3, or 1/6 of a word may be added in an entire (A) Register, giving one sum. Fields or Partial Words may be used in all the arithmetic operations. In multiple arithmetic, the two halves or three thirds of a word may be added in an (A) Register, giving two or three sums respectfully. Subtraction may also be performed in a similar manner.

Instruction type	One address (Modified)
Number range	From $-(2^{35}-1)$ to $+(2^{35}-1)$

Instruction ord format

36 31	30 27	26 23	22 19	18	17	16 1
f	j	a	b	h	i	u

Legend

u - Base Operand Address Designator (16 Bits)
i - Indirect Address Designator (1 Bit)
h - Increment Designator (1 Bit)
b - (B) Register Designator (4 Bits)
a - (A) Register Designator (4 Bits)
j - Partial Word or Minor Function Code (4 Bits)
f - Function Code (6 Bits)

Automatic coding includes ALGOL, with Fortran Translator and COBOL. Basic Utility Library includes an executive routine and an Advanced Computer-Oriented Mnemonic Code Assembly System; also sort-merge and debugging programs.

Registers and B-boxes include 16 (A) Registers (accumulators), 15 Index Registers and 36 Special Control Registers.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	4.0	0.8
Mult	12.7	7.4
Div	31	24
Arithmetic mode	Parallel	
Timing	Synchronous	
Operation	Concurrent	

STORAGE

Media	No. of Words	Total No. of Bin Coded Dec Digits	Access Microsec
Magnetic Core	65,536 max	589,824	1.8
Thin Film	128	1,152	0.3
Drum, FH 500 ea	262,144	2,359,296	8,500 avg
Drum, FH 800 ea	786,432	7,077,888	17,000 avg

	Models IIA	III
No. of units that can be connected	Up to 12 tape units may be connected to one channel. One magnetic tape control unit required per channel.	
No. of char/linear inch	250	1,000 Pulses/in
Channels or tracks (includes parity and timing track)	8	- Tracks/tape
Blank tape between records	1.0	0.75 Inches
Tape speed	100	100 Inches/sec
Transfer rate	25,000	120,000 Char/sec
Start time	12	6.3 Millisec
Stop time	9	6.3 Millisec
Average time for experienced operator to change reel of tape	30	30 Seconds
Physical properties of tape		
Width	0.500	0.500 Inches
Length of reel	2,400	2,400 Feet
Composition	Metallic and Mylar	Metallic and Mylar

INPUT OUTPUT

Media	Speed
Magnetic Tape (Model IIA)	25,000 kilocycles/sec
Magnetic Tape (Model III)	120,000 kilocycles/sec
Paper Tape Reader	400 frames/sec
Card Reader	600 or 700 cards/min
Paper Tape Punch	110 frames/sec
Card Punch	150 or 300 cards/min
Printer	600 or 700 lines/min

The complete line of Univac peripheral devices as well as specialized devices may be used if so desired. The input-output section of the computer has been designed to be adaptable to future peripheral equipments.

Sixteen bi-directional channels are provided.

Up to 12 tape units may be connected to one channel.

One magnetic tape control unit is required per channel.

CHECKING FEATURES

Logical checks include parity bits checking on magnetic tape. Transfer checks are made on all other peripheral devices. Special instructions facilitate program parity checks.

PRODUCTION RECORD

Time required for delivery 18 months

PERSONNEL REQUIREMENTS

Appropriate training courses will be made available to all users.

ADDITIONAL FEATURES AND REMARKS

Outstanding features and unique system advantages include:

A thin-film control memory is used for arithmetic and index registers, for input-output access control and for special controls and for auxiliary storage.

The thin-film storage has a 300 nanosecond (milliμsecond) access time with a complete cycle time of 600 nanoseconds (millimicroseconds).

A ferrite core memory for instructions and operands available in capacities of 16,384 words in one bank; or of 16,384, 32,768, 49,152, or 65,536 words in two separately accessed banks.

Two microsecond effective cycle time for core storage (overlapping of two banks).

There are 36-bit words in both the magnetic film and core memories.

Computer system has an extremely powerful instruction repertoire, including fixed and floating point, integer and fractional arithmetic.

Design includes 16 bi-directional channels, capable of concurrent input-output transmissions up to 250,000 words per second, without direct supervision of the main program.

ALGOL and COBOL compiling programs and a FORTRAN translating program will be provided. (The 1107 will accommodate all routines previously coded in FORTRAN.)

Also provided is an executive routine capable of integrating routines of multiple programs.

The 1107 instruction word format provides for indexing, automatic index-register incrementation, partial word transfers and indirect addressing, along with a current operand reference and specification of an arithmetic register.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

	KVA	Weight Lbs.	Width (INCHES)	Depth (INCHES)	Height (INCHES)	BTU per Hr.
Central Computer	7.5	1,850	74	34.5	82	19.9
Power Control Center	---	800	48	34.5	82	*
Operator Console	---	550	54	35	50	*
Core Memory (65,000 words)	5	2,000	36	34.5	82	14
Magnetic Tape Control	1.9	125	20	34.5	82	5.1
Uniservo IIA Power Supply	12 Units Max. 40.6	3,000	57	32.75	82	10 (for 12 units)
Uniservo IIA	3.1	800	31	34	82	8.5
Magnetic Drum Control	1.5	125	20	34.5	82	4.1
FH 880 Drum Cabinet	1.9	800	50	32.5	49.75	5.1
FH 500 Drum Cabinet	1.6	600	38.25	29.5	46.75	4.5
Model 46 Line Printer Control	1.5	125	20	34.5	82	4.1
Model 46 Line Printer	4.4	1,613	72.25	32	52.5	12
Card Control Cabinet	1.5	125	20	34.5	82	4.1
P19 Card Punch - 80 Column	1.5	1,100	27	49	54.5	4.1
P19 Card Punch - 90 Column	1.5	1,100	27	49	54.5	4.1
M45 Card Reader - 80 Column	1.3	400	27	51	49.25	3.5
M45 Card Reader - 90 Column	1.3	400	27	51	49.25	3.5
Paper Tape Control Cabinet	1.2	800	24	34.5	82	2.6

Note: Tape Reader and Punch included in the Paper Tape Control Unit.
* Included in Central Computer.

Voltages	Frequency
208 ± %	384-440 cps
(208-220) ± 10%	57-63 cps
(208-120)	59.5-60.5 cps

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

	No. of Transistors	No. of Diodes
Central Processor	12,000	60,000
Core Memory (65,000 words)	6,676	10,608
Magnetic Tape Control	1,014	2,894
Uniservo IIA Power Supply	0	0
Uniservo IIA	0	15
Magnetic Drum Control	1,100	3,500
FH 880 Drum Control	1,100	700
FH 500 Drum Cabinet	600	700
Model 46 Line Printer Control	1,250	4,500
Model 46 Line Printer	12	500
Card Control Cabinet	1,000	3,000
Card Punch - 80 Column	75	1,000
Card Punch - 90 Column	75	600
Card Reader - 80 Column	75	500
Card Reader - 90 Column	75	400
Paper Tape Control Cabinet	500	1,500

UNIVAC FILE 0
Univac File Computer Model 0

MANUFACTURER
Remington Rand Division
Sperry Rand Corporation

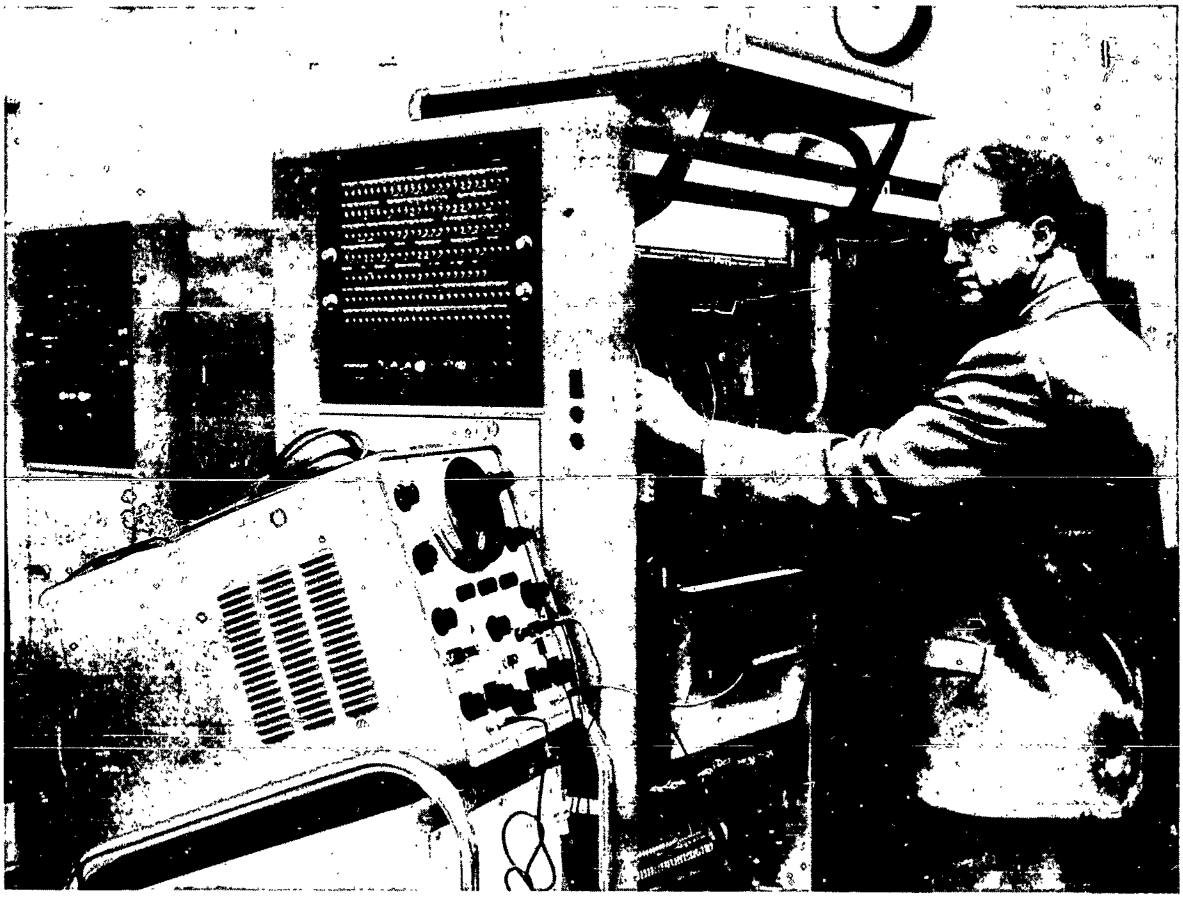


Photo by Michigan Bell Telephone Company

APPLICATIONS

Manufacturer

The Univac File Computer is a general purpose, medium-priced electronic data processing system with a magnetic drum memory. Automatic tape collating and sorting may be performed without requiring computer time, which, during the process, may be spent on other operations. Random access is provided to 180,000 alphanumeric characters on one drum and to the magnetic core memory. A maximum of eight drums may be added to one system. The system is controlled by external panel wiring. Input/output devices consist of an electric typewriter, a punched card unit and a perforated tape unit, a magnetic tape unit and a high-speed printer.

Frankford Arsenal, Comptroller's Office
Located in Building 51, 2nd Floor, the system is used for cost accounting and payroll, including payroll for personal services and printing of payroll checks.

ROAMA, Griffiss AFB, New York
Located in Depot Supply Bldg. No. 1, East Wing, the system is used for requirements computation, appropriation accounting, and CESAC.

Chesapeake and Potomac Telephone Co. of Maryland
Located at 5711 York Road, Baltimore 12, Maryland, the system is used for the rating of long distance messages. Terminating point information is stored on the drums. Calculation of rate is based on location of originating and terminating points, duration and class of call. Rate and miscellaneous billing and statictical data are punched into the message card.

Douglas Aircraft Company, Dept. G-318, Santa Monica
Located at C-107, Long Beach, the system is used for general accounting, labor distribution, cost and expense ledgers, material, and payroll.

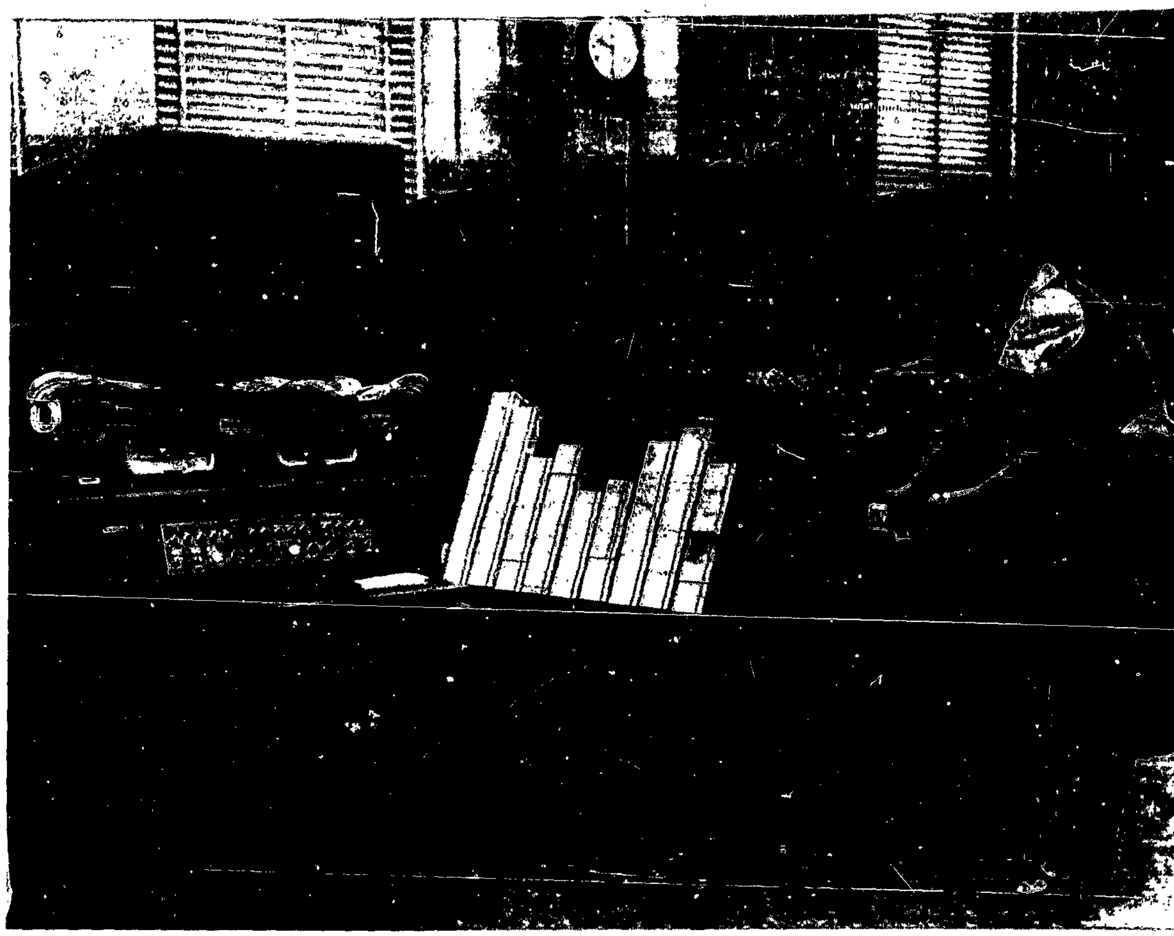


Photo by Michigan Bell Telephone Company

Douglas Aircraft Company, Inc., Tulsa Division
Located at 2000 North Memorial Drive, Tulsa, Oklahoma, the system is used for work determination (search stored master files for technical orders and planned jobs applicable to aircraft coming in for modification), payroll (create payroll working cards and compute earnings and taxes. Update earnings, total-to-date records, and vacation/sick leave records. Create quarterly and year-end tax report cards), cost labor and estimating (summarize hours worked, allocating indirect time to applicable direct charge and create cards for accounting cost labor reports and manufacturing control performance reports and work history), and cost ledger (perform allocations and create cards showing cost of work charged to other divisions of the company.

Michigan Bell Telephone Company
Located at 105 E. Bethune, Detroit, Michigan and 3530 Eastern S. E., Grand Rapids, Michigan, the computers are used to rate "long distance" toll messages.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Bin coded dec (excess 3)
Digits per word	12 digits including sign
Digits/instruction	12 characters/instruction
Instructions per word	1 plus sub command

All instructions are programmed by external plugboard.

Arithmetic system	Fixed point
Instruction type	Three address
Number range	99,999,999,999- to 99,999,999,999+

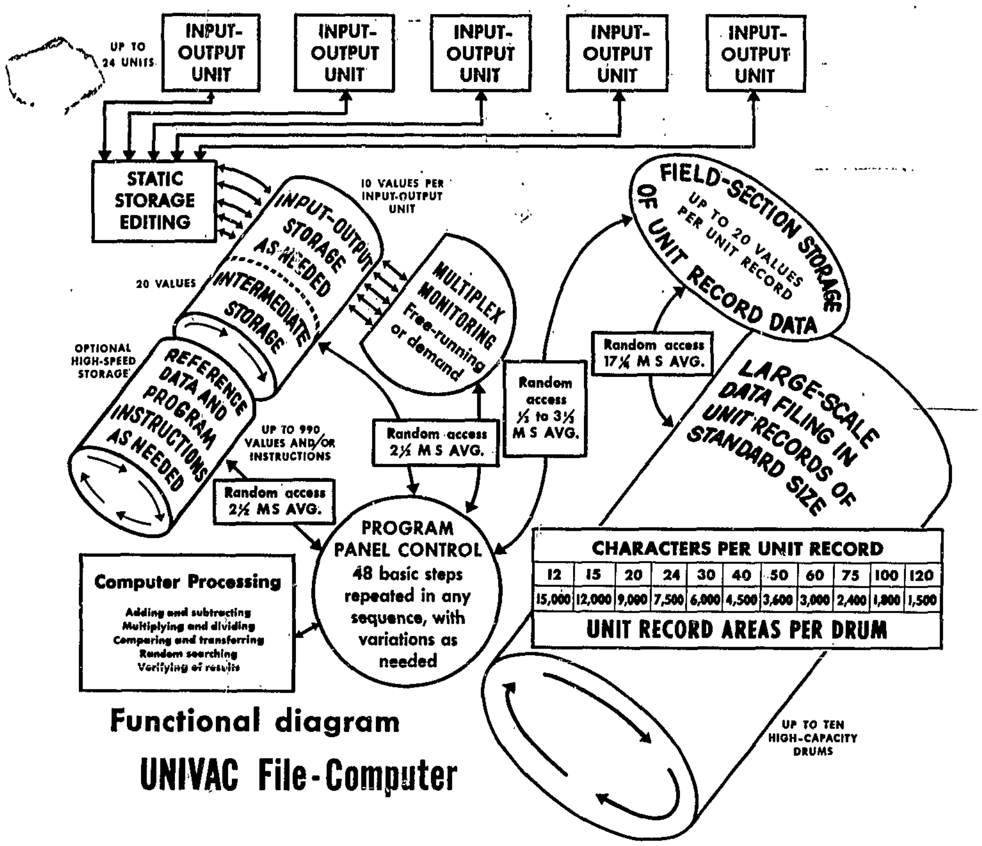
Instruction word format

V_1 Address of first operand	V_2 Address of 2nd operand	R Address for Result Storage	Process	Special Char. Sub-Command
3 digits	3 digits	3 digits	2 digits	

Automatic built-in subroutines includes tape search.
Each register is a 12 character shift register with lower position reserved for algebraic sign.

Register A
Receives first operand

Register B
Receives second operand



Functional diagram

UNIVAC File-Computer

Register C
Accumulates the result in add and subtract operation, in division it receives the remainder, in multiplication it receives most significant product digits.

Register D
Accumulates the result in add and subtract operations, in division it stores the quotient, in multiplication it stores the least significant product digits.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	8,610	1,200
Mult	23,800	16,300 Multiplier = 55555
Div	27,500	approx 20,000 6 digit dividend & 6 digit divisor

The storage access for add, multiply & divide operations includes accessing of the two operands and the result.

Arithmetic mode	Serial
Timing	Synchronous
Operation (System)	Concurrent

STORAGE

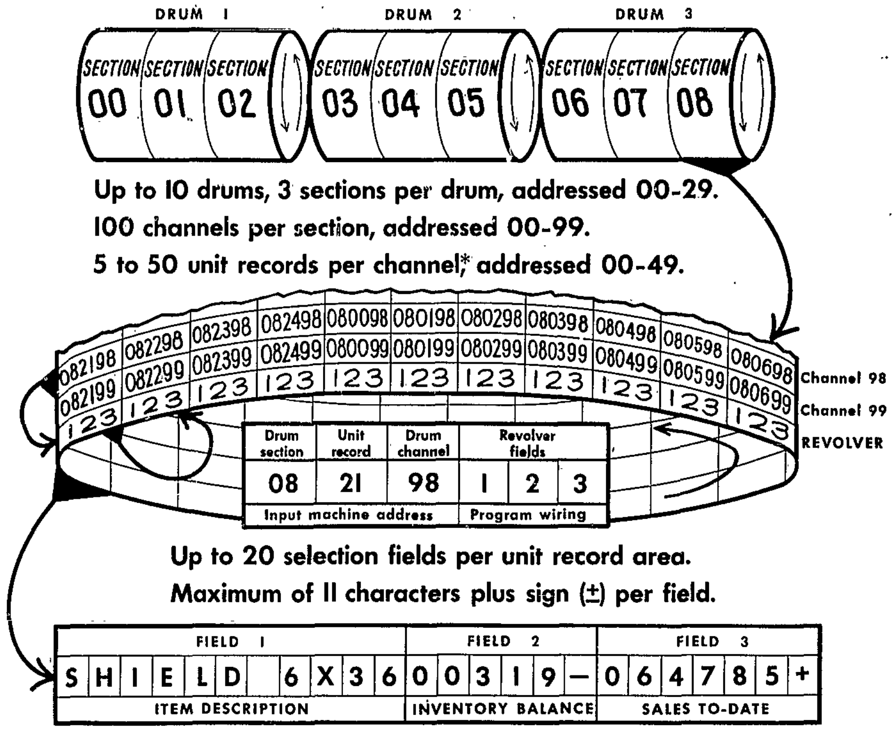
Manufacturer

Media	No. of Words	No. of Alphanum Char	Access Microsec
Drum (High Speed)	1,070	12,840	2,500 avg
Drum (Mass Memory)(optional)	15,000/unit	180,000/unit	17,000
Max. 8 units			

Magnetic Tape

No. of units that can be connected	10 Units
No. of char/linear inch of tape	139 Char/inch
Channels or tracks on the tape	7 Track/tape
Blank tape separating each record	0.5 Inches
Tape speed	75 Inches/sec
Transfer rate	10,425 Char/sec
Start time	7 Millisec
Stop time	10 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Mylar or metal

900 microseconds, above, inlcudes time to transfer one word to an arithmetic register.



HIGH–CAPACITY GENERAL STORAGE

The following installation utilizes 1 General Storage Drum of 15,000 words, 12 characters/word, each:
Frankford

The following installation utilizes 4 General Storage Drums of 15,000 words, 12 characters/word, each:
Michigan Bell Telephone - Grand Rapids

The following installation utilizes 5 General Storage Drums of 15,000 12 characters/word, each:
Michigan Bell Telephone - Detroit

The following installations utilize 6 General Storage Drums of 15,000 words, 12 characters/word, each:
Douglas Santa Monica
Douglas Tulsa

Six large-capacity drums are used. Each drum has 300 "tracks" of 600 digits. "Unit Record" lengths of 12, 15, 20, 24, 30, 40, 50, 60, 75, 100, or 120 digits are available. "Field", or word, lengths within a unit record may vary from 1 to 20 digits, entirely at the discretion of the programmer. Alphabetic characters require only one digit of storage.

The following installations utilize 8 General Storage Drums of 15,000 words, 12 characters/word, each:
ROAMA
C and P Telephone

Each drum has a capacity of 180,000 digits. This is divided into 4500 - 40 digit words. Therefore, the total storage available on the 8 drums is 1,440,000 digits.

INPUT

Manufacturer Media	Speed
Magnetic Tape	10,425 char/sec
Paper Tape	200 char/sec
Card Read/Punch Unit	150 cards/sec

All input devices are on line. 80 or 90 column cards may be used.

The following organizations utilize the input devices indicated:
Frankford
  Cards and magnetic tape
ROAMA
  Cards, magnetic tape and inquiry typewriter
C and P Telephone
  Cards
Douglas Santa Monica
  Cards
Douglas Tulsa
  Cards. An input speed of 600 cards/min. is possible, using all units.
Michigan Bell Telephone - Detroit
  Cards
Michigan Bell Telephone - Grand Rapids
  Cards

OUTPUT

Manufacturer

Media	Speed
Magnetic Tape	10,425 char/sec
Paper Tape	60 char/sec
Card Punch 80 or 90	150 cards/min
High Speed Printer	600 lines/min
Inquiry Typewriter	10 char/sec

Compatibility of tapes is possible with other Univac tape systems. Printer may be operated on or off line.

The following organizations utilize the output devices indicated:

Frankford

Cards, magnetic tape and high speed printer.

ROAMA

Cards, magnetic tape and inquiry typewriter.

C and P Telephone

Cards. Speed on two I.O. units - approx. 160 cards/min. Speed on three I.O. units - approx. 180 cards/min. Application calls for read and punch in same card. Maximum speeds per I.O. are read and/or punch 150 cards/min.

Douglas Santa Monica

Cards

Douglas Tulsa

Cards. An output speed of 600 cards/min. is possible, using all units.

Michigan Bell Telephone - Detroit

Cards

Michigan Bell Telephone - Grand Rapids

Cards

CHECKING FEATURES

Manufacturer

Checking features include odd parity, execution of arithmetic and some transfer instruction with built in checks, complete tape read checks, and logical checks.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer 74.4 KVA 0.95 pf
Power, air conditioner 14.9 Kw
Room size 1,400 sq ft
Capacity, air conditioner 19.8 Tons
Weight, computer 8,000-10,000 lbs

No special facilities are required. Standard 3 phase 220 volt power is used.

Frankford

Power, computer 100 Kw 112 KVA 0.90 pf
Power, air cond 98.8 Kw 70 KVA 0.85 pf
Volume, computer 26,640 cu ft
Volume, air condition 1,530 cu ft
Area, computer 1,800 sq ft
Area, air conditioner 255 sq ft
Floor loading 100 lbs/sq ft
100 lbs concen max
Capacity, air conditioner 60 Tons
Weight, computer 19,430 lbs
Weight, air conditioner 16,900 lbs, incl cooling tower

Plenums - length 48 ft, width 37, height 15 (48' x 37 x 15 = 26,640 cu ft.). Building type - manufacturing type of pre-World War II Type. Building modifications - installation of air conditioner and electrical receptacles. 480V, 60 cycle, 3 phase, stepped down to 230V.

Above power includes peripheral equipment.

ROAMA

Power, computer 94 Kw 3 phase, 4 wire
Power, air condi 27.5 Kw 27.5 KVA 220V, 3 phase, 4 wire
Volume, computer 21,600 cu ft
Volume, air conditioner 1,180 cu ft
Area, computer 2,400 sq ft
Area, air conditioner 150 sq ft
Floor loading 150 lbs/sq ft
2,200 lbs concen max
Capacity, air conditioner 48 Tons
Weight, computer 38,210 lbs
Weight, air conditioner 7,500 lbs

Modified portion of existing permanent type warehouse including installation of raised wood floor with asphalt tile, new partitions to segregate area, air conditioning, lighting and electrical power and distribution.

C and P Telephone

Power, computer 27.0 Kw 29.7 KVA 0.90 pf
Volume, computer 678 cu ft
Volume, air conditioner 96 cu ft
Area, computer 129.1 sq ft
Area, air conditioner 9.7 sq ft
Room size, computer 20 ft x 38 ft
Room size, air conditioner Located in same room
Floor loading 133.1 lbs/sq ft
150 lbs concen max
Capacity, air conditioner 10 Tons
Weight, computer 17,177 lbs

3 phase, 208 volt, 4 wire circuit required for computer voltage regulator. Required - (Line voltage variations exceeded ± 5%) 40 K.V.A. 3-phase 113 Amp-Stabiline rectifier purchased through Remington Rand. Partitioning and ventilating hoods erected.

Douglas Santa Monica

Power, computer 29.5 KVA
Area, computer 180 sq ft
Room size 60 ft x 20 ft
Floor loading 150 lbs/sq ft
2,050 lbs concen max
Capacity, air conditioner 15 Tons
Weight, computer 20,050 lbs
Weight, air conditioner 1,500 lbs

Six inch raised false floor installed over power cables. Exhaust diffusers installed in ceiling for heat dissipation/air conditioning.

Douglas Tulsa

Power, computer 29.5 KVA 0.85 pf 3 phase, 208/230V reg.
Power, air cond 11.2 Kw 15 KVA 0.70 pf
Volume, computer 900 cu ft
Volume, air conditioner 112 cu ft
Area, computer 180 sq ft
Area, air conditioner 16 sq ft
Room size, computer 60 ft x 20 ft
Room size, air conditioner 8 ft x 8 ft
Floor loading 150 lbs/sq ft
2,050 lbs concen max
Capacity, air conditioner 15 Tons
Weight, computer 20,050 lbs
Weight, air conditioner 1,500 lbs

Floor-to-ceiling partitions installed around computer area. Six-inch raised false floor installed over power cables. Three sixty-inch combination exhaust-diffusers installed in ceiling for heat dissipation/air conditioning.

Michigan Bell Telephone - Detroit
Michigan Bell Telephone - Grand Rapids

Power, computer 13.2 Kw 23.3 KVA 0.75 pf
Power, air cond 11.1 Kw 14 KVA 0.75 pf
Volume, computer 12,000 cu ft
Volume, air conditioner 72 cu ft

Area, computer	750 sq ft
Area, air conditioner	36 sq ft
Room size, computer	24 ft x 20 ft
Room size, air conditioner	Ceiling unit
Room size, maintenance	8 ft x 10 ft
Floor loading	164 lbs/sq ft
	650 lbs concen max
Capacity, air conditioner	7 Tons
Weight, computer	15,570 lbs
Weight, air conditioner	900 lbs

The installation of a seven ton air conditioning unit and an extension of our power distribution circuits were the only site preparations required. (We did partition the computer room at Detroit. However, at Grand Rapids, the Univac was installed in an unpartitioned room with other punched card equipment.)

PRODUCTION RECORD

Manufacturer

See Production Record of Univac File Model 1.

The Univac File Model 1 is the current Univac File model being delivered.

COST, PRICE AND RENTAL RATES

Frankford

Basic System

Program Control Unit, Arithmetic Unit = $2,450 + $15= $2,465.

Additional equipment

Sort 1 Collate System	$750
High Speed Printer	2,725
Magnetic Tape Units (6)	4,500
90 Col Card Unit	1,300
General Storage	850

Maintenance included for prime shift.

Extra shift rental/maintenance at $12 per hour per engineer.

ROAMA

Basic system

Main frame	$4,190
Supv. Console	150
Inquiry Typewriter	350
Card Unit	1,300
Unityper	90
Seven Magnetic Tape Units	5,250
Eight General Storage Drums	4,600

Additional equipment

High Speed Printer	$3,300
Sort Collate/four mag. tape units	3,750

Figures shown are monthly prime shift rental rates.

C and P Telephone

Basic system

1 - Arithmetic & Control, 1 - General Storage, and 1 80 Col. I.O. = $4,600.

Additional equipment

1 - 80 col. I.O., and 7 additional drums = $3,750.

3rd I.O. on standby basis at present.

Douglas Tulsa

Basic system

Program Control Unit, Arith,etic Control Unit, General Storage Unit, Four Input-Output Units and Adaptors, Six Large-Capacity Magnetic Drums = $8,790.

Michigan Bell Telephone - Detroit

Michigan Bell Telephone - Grand Rapids

	Price
Central Computer, Input/Output Unit and General Storage	$219,000
One Input/Output Unit	$55,000 ea.
Four General Storage Drums	21,000 ea.
	Rental
Central Computer, 80 Column Input/Output Unit and General Storage	4,350
One 80 Column Input/Output Unit	$1,050
Four General Storage Drums	350 ea.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	3
Coders	2
Clerks	1
Librarians	1
Operators	2
Engineers	1
Technicians	3

Training made available by the manufacturer to the user includes programming schools and sales support personnel.

Frankford

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	1	3
Analysts	2	2
Programmers	7	7
Librarians	1	2
Operators	3	7

Operation tends toward closed shop.

Methods of training used includes 120 hours classroom training by Rem-Rand personnel for programmers, 80 hours classroom training by Rem-Rand personnel and on-the-job training by experienced Arsenal programmers for operators.

ROAMA

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	1	3
Operators	1	3
Engineers	6	9
In-Output Oper	2	6

Operation tends toward closed shop.

C and P Telephone

	One 8-Hour Shift
Supervisors	1
Programmers	2
Operators	2

Programmers and supervisors are part time.

Operators were trained by programmers on-the-job.

Operating instructions are being prepared.

Douglas Santa Monica

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	1
Operators	1

Operation tends toward closed shop.

Methods of training used include two weeks course followed by on-the-job training.

Douglas Tulsa

	One 8-Hour Shift
Supervisors	1
Analysts	3
Operators	2
Engineers	1
Technicians	1

Analysts perform their own programming. No coding

required. Two additional systems analysts available, if needed, from outside the department.

Operation tends toward open shop.

Methods of training used include two-week familiarization course followed by on-the-job training.

Michigan Bell Telephone - Detroit

Michigan Bell Telephone - Grand Rapids

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors	1	1
Programmers	1	1
Operators	1	2
Engineers	2	3

Operation tends toward open shop.

Method of training used is on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Numerous built-in checking features.

Frankford

Average error-free running period 30.3 Hours
Good time 67 Hours/Week (Average)
Attempted to run time 76 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.88
Above figures based on period from Jan 60 to Mar 60
Passed Customer Acceptance Test 15 Jul 59

Time is available for rent to qualified outside organizations. Presently, there is time available on the computer system pending the implementation of further applications. This time would be available in the meantime to an organization or agency with a compatible system.

ROAMA

Good time 119 Hours/Week (Average)
Attempted to run time) 128 Hours/Week (Average)
Operating ratio 0.93
Above figures based on period 1 Feb 60 to 31 Mar 60

Time is not available for rent to outside organizations.

C and P Telephone

Average error-free running period 6.4 Days
Good time 42.33 Hours/Week (Average)
Attempted to run time 42.5 Hours/Week (Average)
Operating ratio 0.996
Above figures based on period 1 Jul 60 to 31 Jul 60
Passed Customer Acceptance Test 1 Feb 60

Time is not available for rent to outside organizations.

New program cutover on 25 Jul 60 - initial program used from Feb 60 until Jul 60. Analysis on new program is not complete.

Douglas Santa Monica

Average error-free running period 40 Hours
Good time 40 Hours/Week (Average)
Attempted to run time 41 Hours/Week (Average)
Operating ratio 0.975
Above figures based on period from Jul 59 to Jul 60
Passed Customer Acceptance Test Jul 58

Time is available for rent to outside organizations.

Douglas Tulsa

Average error-free running period Two Weeks
Good time 44.6 Hours/Week (Average)
Attempted to run time 46 Hours/Week (Average)
Operating ratio 0.97
Above figures based on period 1 Jan 60 to 30 Apr 60
Passed Customer Acceptance Test 1 Sep 57

Time is available for rent to outside organizations.

Michigan Bell Telephone - Detroit

Michigan Bell Telephone - Grand Rapids

Good time 70 Hours/Week (Average)
Attempted to run time 78 Hours/Week (Average)
Operating ratio 0.93
Above figures based on period 1 Apr 60 to 1 May 60
Passed Customer Acceptance Test 1 Sep 59

Time is not available for rent to outside organizations.

We have encountered considerable 80 column punch trouble with the Detroit Univac. The Grand Rapids installation has been, in comparison, trouble free.

ADDITIONAL FEATURES AND REMARKS

Frankford

A unique system advantage is that sort/collate system may be off line or the tape units may be used on-line as demand stations.

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature, and physical, electrical, fire and other damage include labelling (tape number, program number, period ending date, description and blockette count), storage (2 fireproof closed cabinets - 1 open cabinet), protection against atmospheric conditions (air conditioning), and a disaster plan (source tapes stored in separate location) is in effect.

Our Model 0, UFC is composed of a Main Control Unit, an Arithmetic and Control Unit, a General Storage Drum, a 90 column I/O Unit, a 90 column Adaptor, six Tape Units, a Sort/Collate System (Main Control plus four of above tape units), and a High Speed Printer (Printing Unit, Type Reader, Memory Unit, Control Unit).

ROAMA

Tapes are stored in the computer room which is air conditioned and humidity controlled. The room is equipped with a sprinkler system in case of fire however, the tapes are stored in plastic containers and metal filed which are not fireproof. Labels are AMC Form 55 dated Oct. 58.

Douglas Tulsa

An outstanding feature is the magnetic drum storage, which is expandable to 1,800,000 digits on request, and expandable to 5,940,000 digits with circuitry modification.

The unique system advantages include true random access storage and self-checking arithmetic processes.

Michigan Bell Telephone - Detroit

Michigan Bell Telephone - Grand Rapids

Outstanding feature is the random access memory. Unique system advantage is that system rates toll messages in random terminating point order and accumulates statistics and study data.

FUTURE PLANS

Manufacturer

Univac File Model 1 is the current Univac File model.

Frankford

It is planned that additional payroll, budget and program cost applications will be added to the existing equipment as soon as possible. A proposed integrated Financial Management System for the entire Arsenal when implemented would require a computer with a greater potnetial than the one currently in use. It is believed that a computer of the second generation type (transistorized) would prove of greater

benefit to the Arsenal and would eliminate the obsolescence of such equipment for greater period of time.

C and P Telephone

Modifications of 80 column read punch (P-19) presently used on Univac Solid State Computer may permit it to be used on Model 0. This will increase time available for computing from 85 milliseconds to 400 milliseconds. It is anticipated that 2 P-19's would furnish at least the same output volumes as the 3 I.O.'s used presently.

Douglas Santa Monica

System is to be retired within the next few months.

Douglas Tulsa

Two Univac Electronic Tabulators are on order and will provide high-speed printing capability. Each machine consists of a 450-card per-minute reader, a 150 card-per-minute punch, a 600 line-per-minute printer and a processor which includes a 2,400-word (10 digit) drum.

Michigan Bell Telephone - Detroit
Michigan Bell Telephone - Grand Rapids

Several new applications for the Univac are in the planning stage. For the most part, they involve statistical analysis of toll message volume data.

INSTALLATIONS

Frankford Arsenal
Bridge and Tacony Streets
Philadelphia, Pennsylvania

ROAMA
Griffiss Air Force Base, New York

Chesapeake and Potomac Telephone Company of Maryland
5711 York Road
Baltimore 12, Maryland

Douglas Aircraft Company, Dept. C-107
Long Beach, California

Douglas Aircraft Company, Inc.
2000 North Memorial Drive
Tulsa, Oklahoma

Michigan Bell Telephone Company
105 E. Bethune
Detroit, Michigan

Michigan Bell Telephone Company
3530 Eastern S. E.
Grand Rapids, Michigan

UNIVAC FILE I

Univac File Computer Model 1

MANUFACTURER

Remington Rand Division
Sperry Rand Corporation

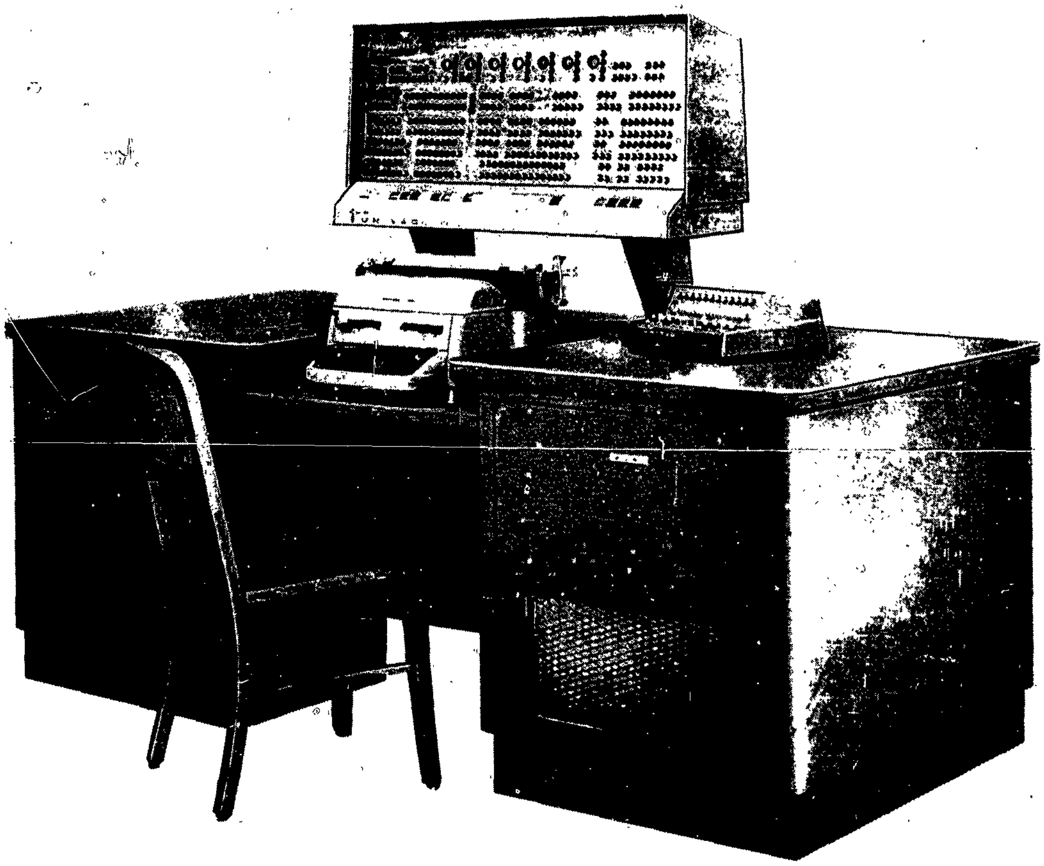


Photo by Remington Rand Univac

APPLICATIONS

Manufacturer

The Univac File-Computer is a general purpose, medium-priced electronic data processing system with a magnetic drum memory. Automatic tape collating and sorting may be performed without requiring computer time, which, during the process, may be spent on other operations. Random access is provided to 180,000 alpha-numeric characters on one drum and to the magnetic core memory. A maximum of ten drums may be added to one system. The system is controlled by external panel wiring and by internally stored programs. Input/output devices consist of an electric typewriter, a punched card unit and a perforated tape unit, a magnetic tape unit and a high-speed printer.

U. S. Army Chemical Center

Supply Management National Inventory Control Point, Army Industrial Fund Inventory, and Army Industrial Fund Cost Accounting.

New applications will include:

Corps wide Appropriation Financial Accounting, surveillance statistics for Chemical Corps materiel, civilian payroll, inventory and supply management of Chemical Corps, inspection aids and equipment, military personnel statistics, and Chemical Corps Tables of Distribution.

U. S. Army Military Traffic Management Agency

Located in Washington, D. C., the system is used by a single manager charged with the responsibility for compiling of statistical data for the Department of Defense on all forms of transportation used by all military departments.

U. S. Marine Corps Supply Center, Albany, Ga.

Located at the Marine Corps Supply Center, Albany, Ga., applications include computer processing under the current Marine Corps concept of supply management, which involves the use of the File Computer as the primary processing tool of the Marine Corps supply

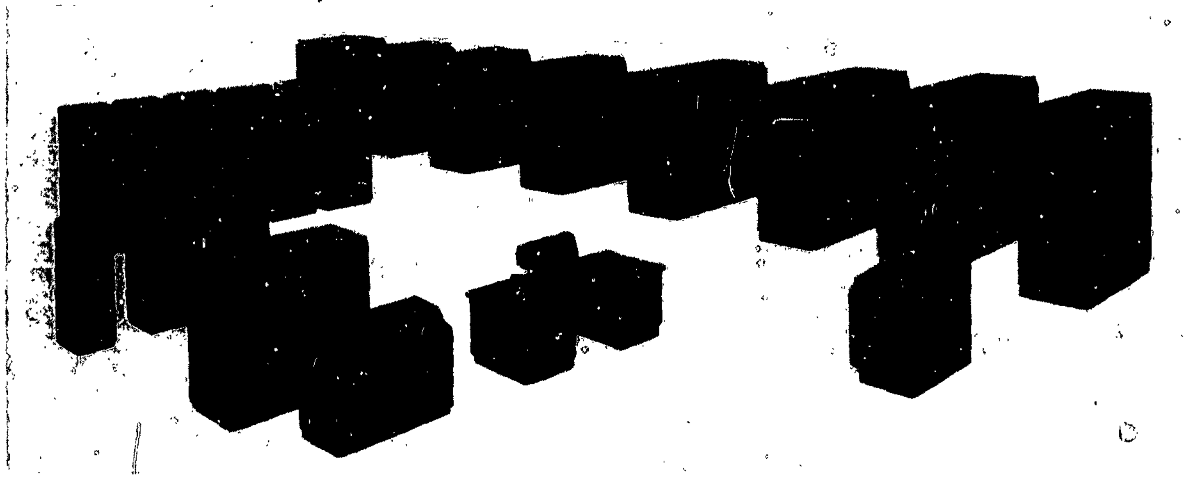


Photo by Remington Rand Univac

centers, and inventory control point. Each of our two supply centers manage a supply complex. For example, this activity is responsible for the area extending east of a north-south line passing through El Paso, Texas including the Near East and Mediterranean areas. All inventory and financial management of stocks at the supply center and the stock account at MCS, Quantico, Va., Camp LeJeune, N.C., and MCRD, Parris Island, S.C., is accomplished by this supply center. The inventory records for each of the above activities are maintained on magnetic tape and updated periodically on our computer. The financial accounting is accomplished to support each inventory updating process.

U. S. Marine Corps Supply Center, Barstow, Calif. Located in the Administrative Division, at Barstow, California, the system is used for supply inventory control and accounting and for stores accounting (monetary value of stores).

USAF Headquarters Command, Bolling AFB
Base inventory control and monetary accounting-Inventory records are maintained on magnetic tape and each day supply transactions (issues, turn-ins, receipts, etc.) update the inventory on hand balances, resulting in requisition, back orders, etc. Entire application consists of approximately 35 programs.

Military personnel accounting - This application provides for the maintenance of personnel strength files on magnetic tape and for periodic summarization of data for submission to Hq USAF. There are approximately 20 programs utilized in support of this application.

Civilian payroll accounting - This application provides for the bi-weekly computation of pay data for 5,000 civilian employees serviced by Bolling AFB.

USAF Sacramento Air Materiel Area, McClellan AFB
System is used for maintenance engineering management and aircraft configuration control for the F-104.

USAF Special Communications Center, Kelly AFB
System is located at San Antonio, Texas.

USAF Warner Robins Air Materiel Area
The computer is used for the property accounting system which encompasses the processing of all documents i.e., requisitions, receipts, IAVs, stock list changes, etc., that effect inventory management stock control and distribution of Air Force controlled inventory. It also originates feeder data for many other systems dealing with material such as IAM, GSSF, maintenance production system, maintenance, supply, civil engineers, administrative services, and tenant organizations, cost system inventory, and stock balance and consumption reporting.

The computer is used for Maintenance Engineering Management - material control and production item reporting. This project provides for control and accounting of material used in the Directorate of Maintenance Engineering repair activities. It includes provisions for maintenance of material standards; computation of material requirements on the 90/180 day programmed workload and other non-programmed work as it generates; preparation of necessary documentation to effect physical movement of stock to the maintenance support stock in conjunction with AMCL 25-156 and to accomplish the determination of support-ability for production; analysis of material usage related to production items; accumulation of cost for actual material consumed; computation of maintenance stock support utilization and effectiveness; accumulation of production data and reporting for the material repair system and other production reporting.

Computer will shortly be used for base support class stock control and distribution. This is a method for controlling and distributing material to support AMC internal depot functions including MOS operation and tenant organizations. The basic function of this system is to provide data required to enable the supply components to administer timely, accurate, and effective material support. The system provides current inventory positions and various products for management of serviceable, reparable, and excess material. The system also provides such by-products of data as can be used in dollar management of AF assets processed by the computer to effect obligation on distribution of material; appropriate reserve level notices; back-order action as appropriate; and preparation of outputs for further use in supply and dollar accounting reports.

Douglas Aircraft Company, Department G-318 No. 1
Located in A7-123 Santa Monica, the system is used for parts sales, provisioning, and inventory.

Douglas Aircraft Company, Department G-318 No. 2
Located in A-312, Santa Monica, California, the system is used for production scheduling, tooling, and material release.

Photo by U. S. Army Chemical Center

Douglas Aircraft Company, Department G-318, No. 3
Located in B-107, El Segundo, the system is used for general accounting, labor distribution, cost & expense ledgers, material, and payroll.

Douglas Aircraft Company, Department G-318, No. 4
Located in C-107, Long Beach, the system is used for general accounting, labor distribution, cost & expense ledgers, material, and payroll.

Douglas Aircraft Company, Department G-318, No. 5
Located at C-107, Long Beach, the system is used for production scheduling, tooling, material release, and order location.

Douglas Aircraft Company, Department G-318, No. 6
Located at A-107, Santa Monica, the system is used for general accounting, labor distribution, cost & expense ledgers, material, and payroll.

First National City Bank of New York
Located at 399 Park Avenue, N.Y.C., the system is used Personnel (daily and monthly absentee report, job classification study, personnel statistic report, and profit sharing studies), by Comptrollers (allocation of departmental budget expense), by the Paymaster (payroll and related reports), by others for salary, employment, vacation studies, and reconcilement of travelers checks. Planned applications include accounting (head office and branch general ledger accounting) and inventory (stationery).

Western Electric Company, Incorporated
Located at 2500 Broening Highway, Baltimore 24, Maryland, the system is used for preparation of hourly payrolls and related report data, employee wage incentive credits and monthly balance earnings, monthly accounting details and report data, merchandise warehouse stock maintenance, and merchandise warehouse inventory control.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded dec (excess 3)
Alphanum char/word	12 char, incl sign
Characters per instruction	12 alphanum
Instructions per word	1 plus sub command
Instructions decoded	Internal 27 plus 11 sub-instructions External 19 plus 17 sub-instructions
Arithmetic system	Fixed point
Instruction type	Three address
Number range	99,999,999,999- to 99,999,999,999+

Photo by U. S. Army Chemical Center

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	8,610	1,200
Mult	23,800	16,300 Multiplier = 55555
Div	27,500	approx 20,000 6 digit dividend & 6 digit divisor

The storage access for add, multiply & divide operations includes accessing of the two operands and the result.

Arithmetic mode	Serial
Timing	Synchronous
Operation (System)	Concurrent

Instruction word format

V_1 Address of first operand	V_2 Address of 2nd operand	R Address for Result Storage	Process	Special Char. Sub-Command
3 digits	3 digits	3 digits	2 digits	1 digit

Automatic built-in subroutines includes tape search.
Each register is a 12 character shift register with lower position reserved for algebraic sign.

Register A
Receives first operand

Register B
Receives second operand

Register C
Accumulates the result in add and subtract operation, in division it receives the remainder, in multiplication it receives most significant product digits.

Register D
Accumulates the result in add and subtract operations, in division it stores the quotient, in multiplication it stores the least significant product digits.

STORAGE

Manufacturer

Media	No. of Words	No. of Alphnum Char	Access Microsec
Magnetic Core	20	240	900
Drum (High Speed	1,070	12,840	2,500 avg
Drum (Mass Memory)(optional) Max. 10 units	15,000/unit	180,000/unit	17,000

Photo by U. S. Marine Corps Supply Center Barstow

Magnetic Tape

No. of units that can be connected	10	Units
No. of char/linear inch of tape	139	Char/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating each record	0.5	Inches
Tape speed	75	Inches/sec
Transfer rate	10,425	Char/sec
Start time	7	Millisec
Stop time	10	Millisec
Average time for experienced operator to change reel of tape	30	Seconds
Physical properties of tape		
Width	0.5	Inches
Length of reel	2,400	Feet
Composition	Mylar or metal	

900 microseconds, above, includes time to transfer one word to an arithmetic register.

USMC SC Albany

Storage capacity of the high speed drum consists of the following categories of tracks.

Tracks 0-9 = Input/output tracks. Each basic track is dual in nature for track switching consequently doubling the storage capacity.

Tracks 11-12 = Factor Storage

Tracks 13-97 = Program Storage

Track 99w = Stores field selection pattern

Western Electric

Media	No. of Words	No. of Digits	Access Microsec
High Speed Drum	1,050	11 + sign/word	Min. 0588
			Avg. 3,087
			Max. 5,586
Large Capacity	Variable	180,000/drum	Avg. 17,000
Storage Drums	Unit Records		Max. 34,000

Unit records can run in multiples of 12 up to 120.

Buffers (Magnetic Core)	20	240	Min. 630
			Avg. 861
			Max. 1,092

Memory Locations

Register "A"	1	11 + sign	
Register "B"	1	11 + sign	
Register "C"	1	11 + sign	Min. 588
Register "D"	1	11 + sign	Avg 819
Instruction Revolver	1	11 + sign	Max. 1,050
General Storage Address Register		7	
Program Address Counters	-	3	
Code Distributor Register	-	1	

Photo by U. S. Marine Corps Supply Center Barstow

The following installations utilize 1 General Storage Drum of 15,000 words, 12 characters/word, each:

USA CC	Douglas 1
USA MTMA	Douglas 2
USAF SCC	

The following installation utilizes 2 General Storage Drums of 15,000 words, 12 characters/word:
USMC SC Barstow

The following installations utilize 3 General Storage Drums of 15,000 words, 12 characters/word, each:
USAF Bolling USAF McClellan

The following installation utilizes 4 General Storage Drums of 15,000 words, 12 characters/word:
1st National City Bank

The following installations utilize 6 General Storage Drums of 15,000 words, 12 characters/word, each:
Douglas 4 Douglas 6

The following installation utilizes 7 General Storage Drums of 15,000 words, 12 characters/word:
Douglas 3

The following installations utilize 8 General Storage Drums of 15,000 words, 12 characters/word, each:
USAF WRAMA Douglas 5

INPUT OUTPUT

Manufacturer

Media	Speed
Magnetic Tape	10,425 char/sec
Paper Tape	200 char/sec
Card Read/Punch Unit	150 cards/sec

All input devices are on line. 80 or 90 column cards may be used.

Media	Speed
Magnetic Tape	10,425 char/sec
Paper Tape	60 char/sec
Card Punch 80 or 90	150 cards/min
High Speed Printer	600 lines/min
Inquiry Typewriter	10 char/sec

Compatibility of tapes is possible with other Univac Tape Systems. Printer may be operated on or off line.

The following organizations utilize the Input/Output devices indicated:

USA CC
Cards, mag tape, typewriter, and high speed printer.

USA MTMA
Cards, mag tape, typewriter, and high speed printer.

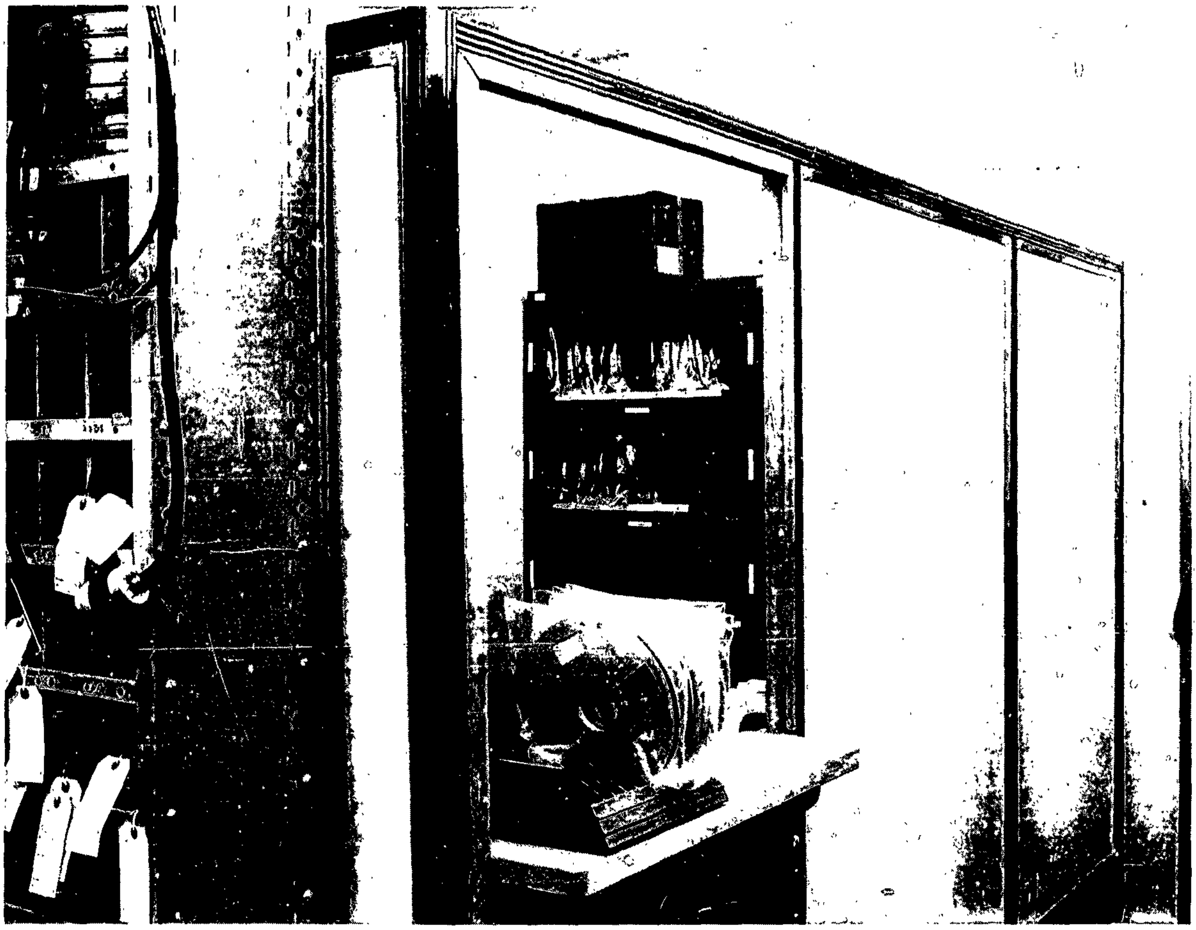


Photo by U. S. Marine Corps Supply Center Barstow

USMC SC Albany

Media	Speed
80 Column Card Unit	300 cards/min

This loading speed is attained bu utilizing both the read and punch channel for reading (punching only rate = 150 cpm)

Magnetic Tape Units	11.5 Millisec

This time represents the speed with which one blockeet (120 characters) of info passes by read write head

Inquiry Typewriter	Manual

Operator must key in desired info for transfer and loading

Media	Speed
80 Column Card Unit	150 cards/min

This component possesses a punching capability in one channel only.

Magnetic Tape Units	Same as input.
Inquiry Typewriter	8.5 Char/sec

USMC SC Barstow
Cards, magnetic tape, typewriter and high speed printer.

USAF Bolling
Cards, magnetic tape and typewriter.

USAF McClellan
Cards, magnetic tape and typewriter.

USAF SCC
Magnetic tape and typewriter.

USAF WRAMA
Cards, magnetic tape and typewriter

Douglas 1
Cards and magnetic tape.

Douglas 2
Cards and magnetic tape.

Douglas 3
Cards

Douglas 4
Cards and magnetic tape

Douglas 5
Cards and magnetic tape

Douglas 6
Cards

1st National City Bank
Cards and magnetic tape. 4 tape units with Sort Collate Control Unit allows off line sort-merge routines.

Western Electric
Cards and magnetic tape.

Photo by U. S. Marine Corps Supply Center Albany

CHECKING FEATURES

Manufacturer

Checking features include odd parity, execution of arithmetic and some transfer instruction with built in checks, complete tape read checks, and logical checks.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer		74.4 KVA	0.95 pf
Power, air conditioner		14.9 Kw	
Room size, computer		1,400 sq ft	
Capacity, air conditioner		19.8 Tons	
Weight, computer		8,000-10,000 lbs	

No special facilities are required. Standard 3 phase 220 volt power is used.

USA CC

Power, computer	28 Kw	30 KVA	0.95 pf
Power, air condi		107 Kw	0.83 pf
Volume, computer		343 cu ft	
Area, computer		752 sq ft	
Floor loading		120 lbs/sq ft	
		140 lbs concen max	
Capacity, air conditioner		80 Tons	
Weight, computer		7,060 lbs	

Converted warehouse type building - approximately 11,000 square feet. False acoustic tile ceiling, tile floor. EAM equipment partitioned separately from computer room. Separate offices for programmers and administrative personnel. Completely rewired and florescent lighting installed.

USA MTMA

Power, computer	88.2 KVA
Volume, computer	16,000 cu ft
Volume, air conditioner	3,600 cu ft
Area, computer	2,000 sq ft
Area, air conditioner	400 sq ft
Weight, air conditioner	2,400 lbs

False ceilings and floors, sound proofing of walls and ceilings, picture windows, wide doors, electrical floor channels, air conditioning ducts, fuse panels and storm windows.

USMC SC Albany

Power, computer	191 Kw	225 KVA	0.85 pf
Power, air condi	170 Kw	200 KVA	0.85 pf
Volume, computer		17,550 cu ft	
Volume, air conditioner		3,861 cu ft	
Area, computer		1,950 sq ft	
Area, air conditioner		429 sq ft	
Room size, computer		L-75, W-26, H-9	
Room size, air condi		L-16.5, W-26, H-9	
Floor loading		17.16 lbs/sq ft	
		55.3 lbs concen max	

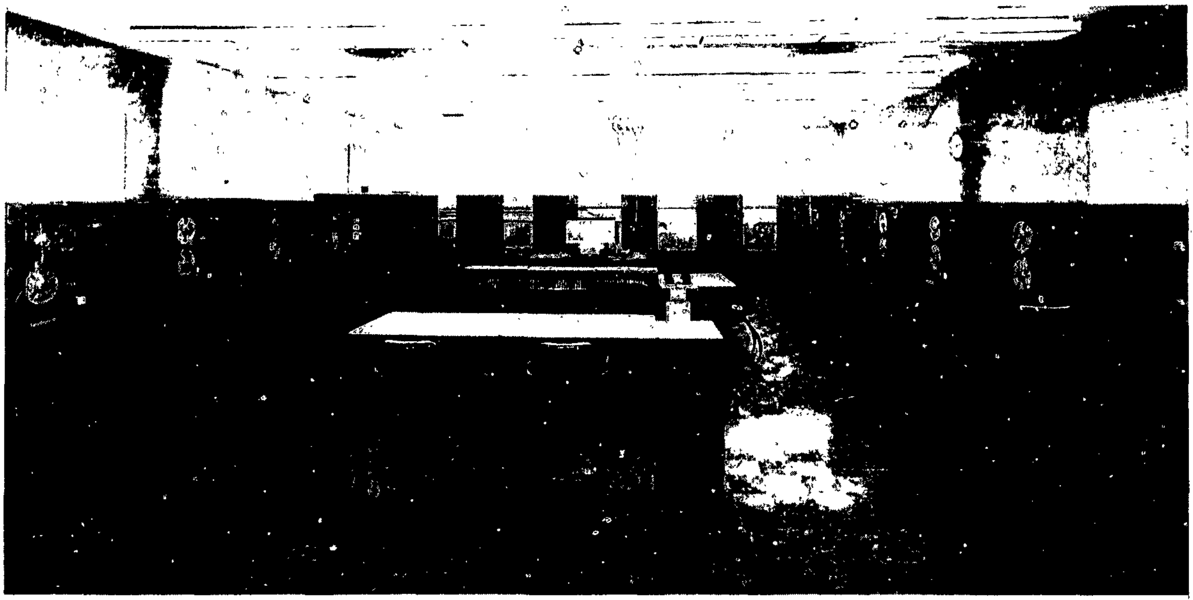


Photo by Bolling Air Force Base

Capacity, air conditioner	60 Tons
Weight, computer	31,472 lbs
Weight, air conditioner	5,360 lbs

Computer utilizes separate power source. Air conditioner shares power source. Approximately 200 KVA available. False floor ratings are uniform load = 150 lbs/sq ft and concen load = 500 lbs/sq ft.

Our computer site was constructed within one wing of an already existing brick and concrete structure. The required floor space was determined utilizing two existing walls of the wing and the rectangular structure was completed by the construction of two concrete block walls. Power requirement were met by installation of a separate transformer bank, voltage regulator and switching gear. Power lines were run through pre-existing control room located in the same wing and then into computer site. Acoustical tile ceiling of permanent structure was retained.

USMC SC Barstow

Power, computer	52.5 Kw	69.6 KVA	0.75 pf
Power, air condi	45.1 Kw	57.4 KVA	0.78 pf
Volume, computer		798 cu ft	
Volume, air conditioner		1,105 cu ft	
Area, computer		166.6 sq ft	
Area, air conditioner		121 sq ft	
Room size, computer		42 ft x 70 ft	
Room size, air conditioner		12 ft x 17.5 ft	
Floor loading		118 lbs/sq ft	
		700 lbs concen max	
Capacity, air conditioner		50 Tons	
Weight, computer		27,930 lbs	
Weight, air conditioner		4,000 lbs	

New wing constructed, size 42 ft x 70 ft, stucco wall, false floor, false ceiling. Hot and cold air plenums, source and exhaust duct work for airflow. Power distribution system including 3 ea 50 KVA and 2 ea KVA transformers, 1 ea 27.5 KVA and 1 ea 90 KVA voltage regulators installed.

USAF Bolling

Power, computer	100.5 KVA
Power, air conditioner	48.672 Kw
Volume, computer	1,229.5 cu ft
Volume, air conditioner	5,600 cu ft
Area, computer	291.0 sq ft
Area, air conditioner	560 sq ft
Room size, computer	40 ft x 60 ft
Room size, air cond (40 Tons)	13 ft x 14 ft
Room size, air cond (15 Tons)	7 ft x 14 ft
Floor loading	140.0 lbs concen max
Capacity, air conditioner	55 Tons
Weight, computer	155,000 lbs
Weight, air conditioner	5,500 lbs

A supply warehouse (Butler Building) was modified. False ceiling, tile floor, air conditioning, wall partitions and the required power supply were added to the building housing the computer and punch card machine areas.

USAF McClellan

Power, computer	56.1 Kw	65.3 KVA	0.86 pf
Power, air condi	160 Kw	200 KVA	0.86 pf
Volume, computer		1,283 cu ft	
Volume, air conditioner		846 cu ft	
Area, computer		2,356 sq ft	
Area, air conditioner		1,881 sq ft	
Room size, computer		38 ft x 62 ft	
Room size, air conditioner		42 ft x 65 ft	
Floor loading		150 lbs/sq ft	
		700 lbs concen max	
Capacity, air conditioner		155 Tons	
Weight, computer		22,520 lbs	
Weight, air conditioner		75,000 lbs	

Air conditioner serves both 1105 and UFC.

A plenum was constructed for the control cabinets, and storage cabinets. Acoustical tile was applied to a false ceiling and to the walls of the room. It was necessary to increase the power to meet the demands of the UFC and 1105. Site preparation for both systems was done simultaneously. Air conditioning was increased and necessary duct work was installed.

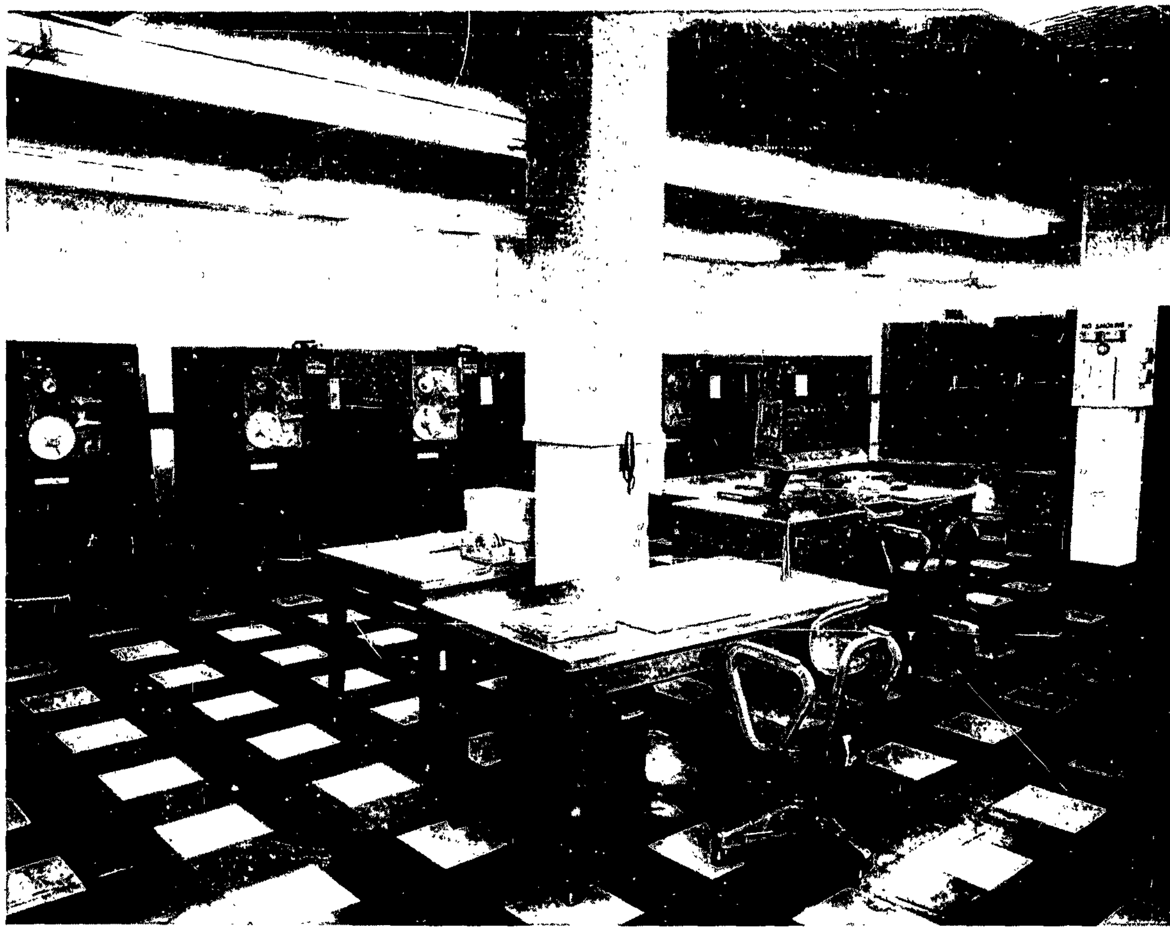


Photo by Sacramento Air Materiel Area McClellan AFB

USAF SCC

Power, computer	111.2 Kw	136.5 KVA
Power, air conditioner		2 Kw ea
Volume, computer		1,624.8 cu ft
Volume, air conditioner		216 cu ft ea
Area, computer		645 sq ft
Area, air conditioner		36 sq ft ea
Room size		50 ft x 40 ft
Capacity, air conditioner		2 - 10 Ton Units
Weight, computer		30,192 lbs

Installation of false floor of 1 1/8 inch plywood covered with vinyl.

USAF WRAMA

Power, computer	94.15 Kw	129.65 KVA
Power, air con	74.6 Kw	100.0 KVA
Volume, computer		8,184 cu ft
Volume, compressor		588 cu ft
Volume, air handling unit		756 cu ft
Area, computer		1,364 sq ft
Area, compressor		84 sq ft
Area, air handling unit		84 sq ft
Room size, computer		2,110 sq ft
Room size, compressor		247 sq ft
Room size, air handling unit		210 sq ft
Floor loading		190 lbs/sq ft
Capacity, air conditioner		29 Tons
Weight, computer		36,278 lbs
Weight, compressor		5,110 lbs
Weight, air handling unit		3,560 lbs
Weight, air condi total		8,670 lbs

Site preparation required the modification and installation of temperature and humidity control for an existing building. The relocation of electrical accounting machine equipment, key punch equipment and supporting personnel was required to provide 2,423 square feet of floor space area for the Univac File Computer System and an equipment maintenance area.

Approximately 29 tons of air conditioning were installed for the File Computer Area. The high speed printer which is cooled by a closed-loop chilled water system required 28 gallons of water per minute at 50°F.

The only false flooring required for the installation of the File Computer System was approximately 360 square feet in the high speed printer area.

The power factor for the computer is between unity and 0.95 inductive. The power factor for the air conditioner, including air handling unit and compressor, are 0.85 to 0.90 fully loaded.

Douglas 1

Power, computer	71 Kw	88.5 KVA	
Area, computer		1,400 sq ft	
Room size, computer		30 ft x 35 ft	
Floor loading		150 lbs/sq ft	
		2,200 lbs concen max	
Capacity, air conditioner		20 Tons	
Weight, computer		22,920 lbs	

Six inch raised false floor to provide for power cables. Exhaust diffusers installed in ceiling for heat dissipation/air conditioning.

Douglas 2

Power, computer	57 Kw	75.5 KVA
Area, computer		1,400 sq ft
Area, air conditioner		100 sq ft
Room size, computer		30 ft x 35 ft
Floor loading		150 lbs/sq ft
		2,200 lbs concen max
Capacity, air conditioner		20 Tons
Weight, computer		18,740 lbs

Six inch raised floor to provide for power cables. Exhaust diffusers installed in ceiling for heat dissipation/air conditioning.

Douglas 3

Power, computer	53 Kw	69.5 KVA
Area, computer		1,000 sq ft
Room size, computer		30 ft x 34 ft
Floor loading		150 lbs/sq ft
		2,200 lbs concen max
Capacity, air conditioner		50 Tons
Weight, computer		23,920 lbs

Six inch raised false floor to provide for power cables. Exhaust diffusers installed in ceiling for heat dissipation/air conditioning.

Douglas 4

Power, computer	72.5 Kw	89 KVA
Area, computer		1,400 sq ft
Area, air conditioner		100 sq ft
Room size, computer		30 ft x 35 ft
Floor loading		150 lbs/sq ft
		2,200 lbs concen max
Capacity, air conditioner		20 Tons
Weight, computer		28,920 lbs

Six inch raised floor to provide for power cables. Exhaust diffusers installed in ceiling for heat dissipation/air conditioning.

Douglas 5

Power, computer	75.5 Kw	92 KVA
Area, computer		1,400 sq ft
Area, air conditioner		100 sq ft
Room size, computer		30 ft x 35 ft
Floor loading		150 lbs/sq ft
		2,200 lbs concen max
Capacity, air conditioner		20 Tons
Weight, computer		31,480 lbs

Six inch raised false floor to provide for power cables. Exhaust diffusers installed in ceiling for heat dissipation/air conditioning.

Douglas 6

Power, computer	51.5 Kw	68 KVA
Area, computer		1,000 sq ft
Area, air conditioner		100 sq ft
Room size, computer		30 ft x 33 ft
Floor loading		150 lbs/sq ft
		2,200 lbs concen max
Capacity, air conditioner		20 Tons
Weight, computer		22,400 lbs

Six inch raised false floor to provide for power cables. Exhaust diffusers installed in ceiling for heat dissipation/air conditioning.

1st National City Bank

Power, computer		88 KVA
Volume, computer		14,400 cu ft
Volume, air conditioner		6,400 cu ft
Area, computer		1,800 sq ft
Area, air conditioner		800 sq ft
Room size, computer		30 ft x 60 ft
Room size, air condi	2 rooms	20 ft x 20 ft
Floor loading		70 lbs/sq ft
Capacity, air conditioner		60 Tons
Weight, computer		30,400 lbs (including peripheral equipment)
Weight, air conditioner		6,000 lbs

Install - roof water tower for air conditioner, air condition room with plenum and ducts to computer room, computer room prepared with wall for prevention of humidity seepage, raceways and floor ducts prepare for electric lines, direct electric line from street, and voltage regulators.

Western Electric

Power, computer	64.8 Kw	76.25 KVA	0.85 overall
Power, air condi	18.0 Kw	22.5 KVA	0.80
Volume, computer		29,400 cu ft	
Volume, equip room		7,500 cu ft	
Area, computer		2,450 sq ft	
Area, equip room		625 sq ft	
Room size, computer		60 ft x 41 ft x 12 ft	
Room size, equip room		25 ft x 25 ft x 12 ft	
Floor loading		10 lbs/sq ft	
		150 lbs concen max	
Capacity, air conditioner		15 Tons (Room only)	
Weight, computer		27,000 lbs	
Weight, air conditioner		10,000 lbs	

Computer installation made in existing building on second floor. Each computer cabinet is air conditioned from a duct beneath the floor. Cabinets are not hooded. Cabinets exhaust into computer room. Return air for under floor system is picked up in room through grilles in ceiling and over cabinets. Separate air conditioning system maintains room air conditions.

PRODUCTION RECORD

Manufacturer

Number produced to date	164
Number in current operation	110
Number in current production	27
Number on order	14
Time required for delivery	6 months

COST, PRICE AND RENTAL RATES

Manufacturer

Quan	Unit	Cost	Monthly Rental
1	Model 1 Computer	$176,000	$4,190

Includes:
- Arithmetic Unit
- Program Control Unit No. 1
- Program Control Unit No. 2
- Multiplex Control for 10 input/output Devices
- High Speed Core Buffer-120 characters
- Plugboard Control-48 Program Steps
- High Speed Storage Drum
  - Dual input/output tracks for each input/output unit
  - 87 Additional High Speed Tracks
  - Field select in tracks for 20 sub track addresses

1	General Storage Unit Includes 1 Drum and Control Circuitry High Speed Core Buffer-120 characters	$59,000	1,400
1	High Speed Printer On line and air cooled	152,600	2,725
4	Magnetic Tape Units, 34,000 each	136,000	3,000 750 ea
1	Inquiry Typewriter	15,000	350
1	Console Control Panel	6,300	150
1	Sort Collate Device Not including Tape Handling Units	34,000	750

Additional Equipment

Additional General Storage Unit w/1 drum	$21,000	$500
Additional General Storage Unit w/2 drums	38,000	900
90 Column Card Sensing Punching Unit	55,000	1,300
80 Column Card Sensing Punching Unit	55,000	1,300
Paper Tape Reading or Punching Unit	61,000	1,450
High Speed Printer On Line or Off Line-Air Cooled	218,400	3,900

Service contract available.

USA CC

Main frame, 6 tape units, 80 column read, punch unit, hi-speed printer-gen storage dr., console, and inquiry typewriter rents for $15,190 per month.

USA MTMA

		Yearly Rental
1	Main Frame consisting of 2 program control units & arithmetic unit at $4,190.	$50,280
1	General Storage Unit at $1,400	16,800
1	Card sensing & punching unit at $1,300	15,600
7	Magnetic tape units at $750	63,000
1	Typewriter inquiry at $350	4,200
1	Console at $150	1,000
1	Sort collate unit at $750	9,000
1	High speed printer & control unit at $3,300	39,600
	Headquarters Computer Total	$200,280

USMC SC Albany

Program control unit no. 1, program control unit no. 2, and arithmetic unit - total approximate cost = $176,000.

General storage control w/2 drums, 80 col. card unit w/adapter, sort/collate control, console and inquiry typewriter, twelve magnetic tape units, and high speed printer - total approx. cost = $783,300.

Program control unit no. 1, program control unit no. 2, and arithmetic unit - rental rate = $4,190 per month (176 prime hours)

General storage control w/2 drums, 80 col. card unit w/adapter, sort/collate control, console & inquiry typewriter, twelve magnetic tape units, and high speed printer - rental rate = $16,750 per month (176 prime hours)

All EDP equipment shown above is rented. Maintenance/service cost included in rental.

USMC SC Barstow
Type 1 Univac File Computer System
Contract No. GS-00S-23295
Period July 1, 1959 thru June 30, 1960

Description	Mach. No.	Monthly Rate
Prog. Control Unit No. 1	901	$4,190
Arithmetic Unit		
Prog. Control Unit No. 2		
General Storage Unit	950	1,400
EXT. Storage Unit 1 Drum	960	500
Console Control Panel	901	150
Sense & Punch Unit	910	1,300
Sense & Punch Control Unit		
Magnetic Tape Unit No. 85	931	750
Magnetic Tape Unit No. 57	932	750
Magnetic Tape Unit No. 98	933	750
Magnetic Tape Unit No. 53	934	750
Magnetic Tape Unit No. 91	935	750
Magnetic Tape Unit No. 58	936	750
Magnetic Tape Unit No. 54	937	750
Magnetic Tape Unit No. 59	938	750
Typewriter Unit	901	350
Typewriter Inquiry Desk	901	350
Sort Collate Unit	970	750
H.S. Printer Head	920	3,300
H.S. Memory Unit		
H.S. Power Supply		
H.S. Mod. UN. Servo		
	Total	$17,940

Maintenance included in rental contract.

USAF Bolling

	Cost	Monthly Rental
Central Processor	$176,000	$4,190
General Stor Control	59,000	1,400
General Stor Drum (3)	59,000	1,400
Read Punch Unit	55,000	1,300
Tape Units (9)	306,000	6,750
Sort-Collate	34,000	750
Inquiry Typewriter	15,000	350
Console	6,300	150
Printer	185,000	3,300

Maintenance/service contract - extra shift - $12 per hour per man.

USAF McClellan

6 Tape units, 1-inquiry typewriter, 1-console, 2-control cabinets, 1-arithmetic unit, 3-magnetic drums, 2-bull units, 2-80 col. card adapters, and 1-general storage rents for $14,090 per month.

2-high speed printers, 1-card-to tape converter, 1-tape to-card converter rents for $11,620 per month.

USAF SCC

Basic System		Monthly Rental
UFC-1		$4,190
2-S/C Units		1,500
12 MTU	($750 ea)	9,000
High speed printer		3,300
Additional Equipment		
General Storage Control		900
High Speed Drum		500
Console		150
Typewriter		350

USAF WRAMA

Rental contracting and rates for basic system

Univac File Computer Model 1

Includes:

Arithmetic Unit	$4,190
Program Control Unit No. 1	
Program Control Unit No. 2	
General Storage Control Unit with one drum	1,400
General Storage Extension Cabinet with one drum	500
(3) General Storage Extension Cabinets with six drums	2,700
80 Column Card Input-Output with Control Unit	1,300
(8) Magnetic Tape Units	6,000
Inquiry Typewriter	350
Console Control Panel	150
Total	$16,590

Rental rates for additional equipment

Sort-Collate Unit	$750
(4) Magnetic Tape Units	3,000
High Speed Printer	3,300
Total	$7,050
	$16,590
	7,050
	$23,640

Douglas 1

Main frame, 4-read-punches, typewriter console, sort collate and five magnetic tape units $10,000/month.

Maintenance/service contracting included in rental

Douglas 2

Main frame, 2 read-punches, 1 large capacity drum, 1 sort-collate, and 5 magnetic tape units $11,000 per month.

Maintenance/service contract included in rental.

Douglas 3

Main frame, 4 read-punches, typewriter console, and 7 extension drums $9,200/month.

Douglas 4

Main frame, 2 read-punches, typewriter console, sort-collate, 5 magnetic tape units, and 6 large capacity drums $12,000/month.

Maintenance/service contract included in rental.

Douglas 5

Main frame, 2 read-punches, typewriter console, sort-collate, 6 magnetic tape units, and 8 large capacity drums $13,000/month.

Maintenance/service contract included in rental.

Douglas 6

Main frame, 4 read-punches, typewriter console, 6 extension drums $9,300/month.

Maintenance/service included in rental.

1st National City Bank

Program Control Unit No. 1 and No. 2 plus arithmetic unit $4,190 per month.

General storage control plus 4 drums	$2,300
7 tape units	4,350
2 80 column read/punch units	2,350
1 Sort collate control	600
Printer	2,000
Typewriter console	250

Maintenance/service contract included in rental fee.

Western Electric

	Monthly Rental
1 Model I Basic Computer, includes:	$4,190
Arithmetic Unit, Type 6901	
Program Control Unit No. 1, Type 6900	
Program Control Unit No. 2, Type 6903	
Multiplex Control for 10 input/output stations	
Code Distributor	
Channel Search, equal or unequal commands	
High speed core buffer, 120 characters	
Track accessibility, track & buffer on track, word and field addressible.	
Internally stored programming	
Plugboard control, 48 program steps	
High speed storage drum	
Dual input/output tracks for each input/output unit	
87 additional high speed storage tracks	
Field selection tracks for 20 sub track addresses	
Additional equipment	
1 Model I General Storage Unit - Type 6902, includes:	$1,400
One drum and control circuitry	
Storage capacity 300 tracks, 600 characters each variable unit record length permits each track to be sub-divided into unit records of 12 characters each. Each unit record is divisible into 120 fields.	
High speed core buffer, 120 characters	
3 Additional Model I Storage Drums, includes:	1,400
Extension cabinet with 1 drum, Type 6912 ($500)	
Extemsion cabinet with 2 drums, Type 6922 ($900)	
1 90 Column Sensing Punching Unit, full post read, Type 4931	1,300
6 Magnetic Tape Units, Type 4950 w/control unit, Type 4850 at $750 each.	4,500
1 Sort Collate Unit, Type 4955	750
1 Inquiry Typewriter, Type 4962	350
1 Console Control Panel, Type 4963	150
1 Univac High Speed Printer, Off-line only, includes:	3,300
Printer Unit, Type 4996	
Control Unit, Type 4896	
Magnetic Tape Unit, Type 4951	
Manual Paper Tape Loop Punch No. 800376	
Total	$13,150

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	3
Coders	2
Clerks	1
Librarians	1
Operators	2
Engineers	1
Technicians	3

Training made available by the manufacturer to the user includes programming schools and sales support personnel.

USA CC

	One 8-Hour Shift Used	Recommended
Supervisors	5	6
Analysts, Programmers & Coders	15	
Clerks	2	
Operators	2	
In-Output Oper	1	

Number of analysts, programmers and coders is sufficient for the three applications being developed.

Methods of training used includes Remington Rand instructors, ORD Management Engineering Training Agency, and on-the-job.

USA MTMA

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	U	R	U	R	U	R
Supervisors	2	2	1	2	1	2
Analysts	2	4				
Programmers	4	4				
Coders		4				
Clerks		1				
Librarians	1	1		1		1
Operators	2	2	2	2	2	2
Engineers		2				
Technicians		2				
In-Output Oper		2				
Tape Handlers		2				

Operation tends toward open shop.

Methods of training used include manufacturer's programming training courses and on-the-job training for operators.

USMC SC Albany

Supervisors	1	1	1	2	1	3
Analysts	1	2	1	2	1	2
Programmers	6	6	6	6	6	6
Librarians	1	1	1	2	1	3
Operators	4	4	8	8	8	12
Engineers	2	2	4	4	6	6

In order to properly evaluate the personnel requirements reflected above, certain operating characteristics of this EDP installation must be considered.

Our computer programs are relatively stable. We process utilizing two major computer programs and our working shifts are varied. In most cases to satisfy the fluctuation in processing volume.

The majority of our present day programming effort concerns the implementation of changes and refinement of the two major programs. Acceptance and programming of new computer applications are limited because of lack of available machine time.

No civilian personnel are presently employed in our EDP operation. Military tables of organization do not facilitiate inclusion of multiple billets for additional operating shifts even though required and/or desired.

Utilize equipment manufacturer's schools and extensive period of on-the-site training under direct supervision of skilled personnel.

USMC SC Barstow

Supervisors	1	1	2	2	3	3
A, P and C	9 (For all three jobs on all shifts)					
Librarians	1	1				
Operators	2	2	4	4	6	6
Eng & Tech	2	2	4	4	6	6
In-Out & Tape	3	3	6	6	9	9

3 - 8 hour shifts not used every day, dependent upon workload. Military training duties require alternates.

Methods of training used includes contractor conducted classes and on-the-job training.

USAF Bolling

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	9	9
Analysts	1	3
Programmers	27	25
Clerks	30	30
Librarians	1	3
Operators	7	9
In-Output Oper	45	57

Operation tends toward open shop.

Methods of training used includes Manufacturer's Programming Courses and on-the-job training.

USAF McClellan

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	4	4
Librarians	3	4
Operators	18	18

Same supervisors in charge of both UFC and 1105.

Same librarians support both UFC and 1105.

Analysts and programmers support the 650, 1105 and UFC systems.

Manufacturer training and on-the-job training is utilized.

USAF SCC

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors	8	9
Analysts	4	4
Programmers-Coders	18	18
Clerks	1	1
Operators-Librarians	5	5
Engineers-Technicians	2	2
Input Oper	1	

Third shift is used for maintenance. Programmers are also required to do EAM project planning, and all coding. Analysts also do programming if required.

Operation tends toward closed shop.

Methods of training used includes Sperry-Rand instructors for operators and programmers and on-the-job training by experienced operators.

USAF WRAMA

Formal classroom training is conducted by the manufacturer for both operating and programming personnel. On-the-job training is conducted by senior operators, programmers, and supervisory personnel.

Douglas 1

	One 8-Hour Shift
Supervisors	2
Analysts	1
Programmers	3
Operators	3

Operation tends toward closed shop.

Methods of training used includes two weeks course followed by on-the-job training.

Douglas 2

Supervisors	3
Analysts	2
Programmers	5
Operators	4

Operation tends toward closed shop.

Methods of training used includes two week course followed by on-the-job training.

Douglas 3

Supervisors	2
Analysts	2
Programmers	1
Operators	3

Operation tends toward closed shop.

Methods of training used includes two weeks course followed by on-the-job training.

Douglas 4

Supervisors	2
Analysts	1
Programmers	2
Operators	3

Operation tends toward closed shop.

Methods of training used includes two weeks course followed by on-the-job training.

Douglas 5

	One 8-Hour Shift
Supervisors	2
Analysts	1
Programmers	2
Operators	3

Operation tends toward closed shop.

Methods of training used includes two weeks course followed by on-the-job training.

Douglas 6

Supervisors	1
Analysts	3
Programmers	2
Operators	3

Operation tends toward closed shop.

Methods of training used includes two week course followed by on-the-job training.

1st National City Bank

Supervisors	1
Analysts	5
Programmers	2
Clerks	2
Operators	6
Technicians	3

Analysts are Research & Development staff who program additional applications and assist in revision of present programs.

Operators handle all phases of operation including tape handling, etc.

Operation tends toward open shop.

Methods of training used includes Remington Rand Programming School, and on-the-job training.

Western Electric

Supervisors	5
Analysts	6
Programmers	4
Librarians	1
Operators	2
Technicians	1

Operation tends toward open shop.

Methods of training used includes instruction classes conducted by computer manufacturer, reviewing existing operations, and assisting with simple development studies.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Numerous built-in checking features.

USA CC

Good time 494.7 Hours/Week (Average)
Attempted to run time 511.1 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.967
Above figures based on period 2 May 60 to 15 Jun 60
Passed Customer Acceptance Test 21 Apr
Time is not available for rent to outside organizations.

USA MTMA

Average error-free running period 4 Hours
Good time 50 Hours/Week (Average)
Attempted to run time 60 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.83
Above figures based on period 1 Mar 59 to 31 May 60
Passed Customer Acceptance Test 1 Mar 59
Time is not available for rent to outside organizations.

USMC SC Albany

Average error-free running period 87.4 Hours Week
Good time 90 Hours/Week (Average)
Attempted to run time 96 Hours/Week (Average)
Operating ratio (Good/Attempted to run time 0.938
Above figures based on period from Oct 59 to Apr 60
Passed Customer Acceptance Test Oct 58
Time is not available for rent to outside organizations.

Above computations are based on an average processing week consisting of 14 hour shifts on 4 days and 20 hour shifts on 2 days for a total of 96 processing hours per week. The "average error-free running time" represents the "good time" less the time lost as a result of program and/or operator error only while the "good time" is the "attempted to run time" less that time lost as a result of equipment failure only.

USMC SC Barstow

Average error-free running period 16.7 Hrs/day
Good time 90.6 Hours/Week (Average)
Attempted to run time 92.3 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period 28 Mar 60 to 5 Jun 60
Passed Customer Acceptance Test Dec 58
Time is not available for rent to outside organizations.

5.3 hrs lost time due to power failure, and 0.9 hrs lost time due to air conditioner failure out of 16.7 hrs lost.

USAF Bolling

Average error-free running period 3 Hours
Good time 94 Hours/Week (Average)
Attempted to run time 100 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period from Feb 60 to Apr 60
Passed Customer Acceptance Test 6 Mar 59
Time is not available for rent to outside organizations.

USAF McClellan

Good time 116 Hours/Week (Average)
Attempted to run time 121 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.958
Above figures based on March and April 1960
Passed Customer Acceptance Test 19 May 59
Time is not available for rent to outside organizations.

Good time includes set up. Five hours is unscheduled maintenance.

USAF SCC

Good time 35/97/73 Hours/Week (Average)
Attempted to run time 40/112/83 Hours/Week (Average)
Operating ratio 0.875/0.865/0.88
Above figures based on period from Sep 59 to May 60
Time is not available for rent to outside organizations.

The main frame is operated only on an 8 hr. prime shift, 5 days a week. The Sort/Collate Units are operated on two 8 hr. shifts, 7 days a week, and the printer is operated about 1 1/2 8 hr. shifts (variable) 7 days a week; therefore, figures above are broken out in three groups: 1st group, Main frame; 2nd group, S/C Units; 3rd group, Printer.

USAF WRAMA

Average error-free running period 3.4 Hours
Good time 111.8 Hours/Week (Average)
Attempted to run time 115.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period 1 Apr 60 to 30 Apr 60
Passed Customer Acceptance Test 18 Sep 59
Time is not available for rent to outside organizations.

Douglas 1

Average error-free running period 44 Hours
Good time 60 Hours/Week (Average)
Attempted to run time 60+ Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.967
Above figures based on period from Mar 59 to Jul 60
Passed Customer Acceptance Test Mar 59
Time is available for rent to outside organizations.

Douglas 2

Average error-free running period 40 Hours
Good time 60 Hours/Week (Average)
Attempted to run time 64 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period from Oct 58 to Jul 60
Passed Customer Acceptance Test Oct 58
Time is available for rent to outside organizations.

Douglas 3

Average error-free running period 48 Hours
Good time 40 Hours/Week (Average)
Attempted to run time 41 Hours/Week (Average)
Operating ratio 0.97
Above figures based on period from Jul 59 to Jul 60
Passed Customer Acceptance Test Jul 59
Time is available for rent to outside organizations.

Douglas 4

Average error-free running period 35 Hours
Good time 80 Hours/Week (Average)
Attempted to run time 81 Hours/Week (Average)
Operating ratio 0.968
Above figures based on period from Apr 59 to Jul 60
Passed Customer Acceptance Test Apr 59
Time is available for rent to outside organizations.

Douglas 5

Average error-free running period 38 Hours
Good time 60 Hours/Week (Average)
Attempted to run time 62 Hours/Week (Average)
Operating ratio 0.973
Above figures based on period from Mar 60 to Jul 60
Passed Customer Acceptance Test Mar 60
Time is available for rent to outside organizations.

Douglas 6

Average error-free running period 48 Hours
Good time 60 Hours/Week (Average)
Attempted to run time 62 Hours/Week (Average)
Operating ratio 0.97
Above figures based on period from Jun 59 to Jul 60
Passed Customer Acceptance Test Aug 58
Time is available for rent to outside organizations.

1st National City Bank

Good time 39 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio 0.97
Above figures based on period from Jan 60 to Apr 60
Passed Customer Acceptance Test Feb 59
Time is not available for rent to outside organizations.

Western Electric

Average error-free running period 15 Hours
Good time 61 Hours/Week (Average)
Attempted to run time 62 3/4 Hours/Week (Average)
Operating ratio 0.97
Above figures based on period 28 Mar 60 to 26 Jun 60
Passed Customer Acceptance Test 1 Jul 59
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features are flexibility (random access storage) and various input-output devices are shared time operation.

Fireproof vault for storing tapes. Tape sorting and collating device available.

Randex mass memory available 6,000,000 char/drum unit.

USA CC

Buffering in all input/output units as well as main frame - time sharing capabilities of I/O equipment, i.e., drum or tape search; the main frame can be computing while these operations are being carried on.

USA MTMA

Sort/Collate System allows sorting, merging, sequence checking, duplicating and extracting off line, and the tape units used with this system may be used on line as needed.

USMC SC Albany

Outstanding features include flexibility of input/output equipment, time sharing features, internal and external programming, self checking features, automatic data translation, and three-address logic in single instruction.

Tape handling:

Color coded labels containing the process number, brief nomenclature, process date, reel numer of reel file, and internal label information consisting of day, month, year and reel number of reel file. Tape storage consists of a primary location adjacent to computer with same temperature and humidity control as computer room and an alternate storage location containing necessary duplicate record tapes. All tape reels are kept in individual plastic containers and stored in partitioned metal cabinets. Tapes are shipped in telescoping solid fiber containers.

USMC SC Barstow

Outstanding feature is flexibility of magnetic tape units and off-line sort collate capabilities.

Magnetic tape handling:

Tapes are labelled with color coded labels denoting specific program and day of processing.

Rotation system of grandfather, parent, offspring tape generation used for all files except program tapes. Tape storage divided into two separate buildings to prevent entire file destruction.

Tape storage and operating areas humidity and temperature controlled.

Tapes stored in tape racks enclosed in steel cabinets.

Tape shipments are made in special pressboard containers; all tapes have identifying numbers and receipt system is employed.

Computer and storage areas protected by high pressure automatic sprinkler system. CO_2 bottles located in computer room for small fires.

USAF Bolling

Outstanding features include large drum storage capacity for storing the more comprehensive programs and read-write-compute overlap.

Tapes are numbered and assigned to specific application in blocks of numbers i.e., Supply Master Record-Tape No. 30 - 44 provides 3 tapes per day for 5 days. Periodically backup tapes are removed to another physical location in anticipation of disaster. Tapes require periodic airing (pass thru a tape unit) to insure maximum performance.

USAF McClellan

The sort collate unit relieves the main frame for computing operations while sorting and merging operations are being performed.

Individual tape units can be off lined at will and used to perform sequence checking and searching operations without utilizing the main frame of the computer.

Tape is stored in concrete fire proof vault and a fire resistant room. Tape storage area has humidity and temperature control. The tape is identified in the first block of the tape, also a label is attached to the outside of the container and on the reel itself.

USAF SCC

Individual sort/collate system. Printer control panel. Flexibility to call up information on individual components.

Magnetic tape labelling:

Labelled by numbered tag attached to reel, protected from ablve by metal cabinets (not fire proof).

USAF WRAMA

Tape labelling:

Magnetic tape labelling is accomplished by writing a label on the tape consisting of a description of the file, the reel number, and the date. A label may vary from one word (maximum of 12 digits) to two words in length. In addition to the above each reel of tape is tagged with an AMC Form 55, EDPE Tape Identification, which consist of a six digit job number and a job description.

Tape storage:

Tape reels are placed in individual plastic containers and stored in a fire-proof tape vault which is humidity controlled. Tape movement into and out of the tape vault is controlled by a tape librarian.

Douglas 3

Outstanding feature is random access storage.

1st National City Bank

Outstanding features are the random access drums and the off line sort collate feature.

Computer labels tape, tape reel is numbered, use is recorded, stored in vault (RIR Tape Bins) and vault is fire protected and air and humidity conditioned.

Western Electric

Outstanding features are large capacity storage drums and sort collate system-sort, merge, collate, etc., magnetic tapes.

Tapes are controlled by tape librarian. Use 1" x 3" gummed labels for tape labelling and stored in plastic containers in tape cabinets in air conditioned room which is humidity controlled.

Tape room protected from fire by sprinkler system.

FUTURE PLANS

USMC SC Albany

To date a study has been conducted on the possible employment of a solid state computer, the Remington Rand USS 80 in conjunction with our present system. This new equipment would replace certain components of our Univac File Computer thereby facilitating an increase in our processing capabilities while maintaining relatively the same monthly rental expenditure. The proposal is under study at Headquarters Marine Corps.

A major re-programming effort will commence in the near future for the purpose of including new concepts developed by observation and study of our present programs, new and varied requirements of the computer serviced functions and incorporation of new programming techniques derived during the past 2 1/2 years of operation.

USMC SC Barstow

Proposal for installation of additional equipment to modify present system under study at Headquarters, U. S. Marine Corps.

USAF Bolling

Plan to augment the Univac File Computer with a Univac Solid State 80. This would provide increased processing capability to convert the following applications:

Unit Manning Document Application - A system to account for manpower space allocations for all organizations of Headquarters Command.

Unit Allowance List Applications - A system for maintaining in use and authorized unit supply records for all equipment issued to support base organizations' missions.

Comprehensive Civilian Pay and Leave Accounting Application - This is a comprehensive system which produces payroll register, checks, bonds, expense distribution reports, payroll reconciliations, W-2 statements and appropriation data.

USAF McClellan

It is planned (machine time permitting) to put a Base Support Control Distribution application on the Univac File Computer.

USAF SCC

Plan to release the UFC-1 and install an IBM 705 and two 1401 systems. Also plan to release an IBM 101 and replace it with a 108.

1st National City Bank

Planned applications include accounting (Head Office and Branch General Ledger Accounting) and inventory (stationery).

Western Electric

Currently making feasibility studies of Remington Rand Univac III and similar equipment manufactured by IBM, RCA and Minneapolis-Honeywell.

Future applications include production control in several operating shops, cost bulletin revision in one selected shop, monthly payroll, machine capacity hours, and ordering, scheduling and manufacture of toll cable.

INSTALLATIONS

U. S. Army Chemical Center
Army Chemical Center, Maryland

U. S. Army Military Traffic Management Agency
Washington 25, D. C.

U. S. Marine Corps Supply Center
Albany, Georgia

U. S. Marine Corps Supply Center
Barstow, California

U. S. A. F. Headquarters Command
Director of Statistical Services, DCS/Comptroller
Bolling Air Force Base, Washington 25, D. C.

Sacramento Air Materiel Area
Data Systems Division, Comptroller
McClellan Air Force Base, California

U. S. Air Force Special Communications Center
Kelly Air Force Base
San Antonio, Texas

Warner Robins Air Materiel Area
Data Systems Division, Comptroller
Robins Air Force Base, Georgia

Douglas Aircraft Company, Department G-318 (3)
3000 Ocean Park Blvd.
Santa Monica, California

Douglas Aircraft Company, Department B-107 (1)
El Segundo, California

Douglas Aircraft Company, Department C-107 (2)
Long Beach, California

First National City Bank of New York
55 Wall Street
New York 15, N. Y.

Western Electric Company, Incorporated
Business Methods Development Department, 33
2500 Broening Highway
Baltimore 24, Maryland

UNIVAC LARC

Universal Automatic Computer Model LARC

MANUFACTURER

Sperry Rand Corporation
Remington Rand Univac Division

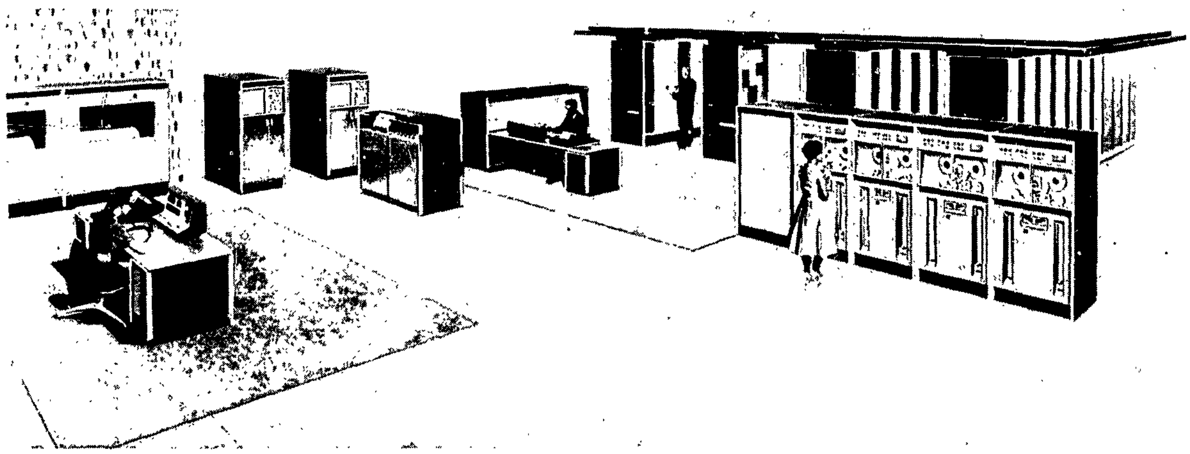


Photo by Remington Rand Univac Division of Sperry Rand Corporation

APPLICATIONS

Manufacturer

Univac LARC is designed for large-scale business data processing as well as scientific computing. This includes any problems requiring large amounts of input/output and extremely fast computing, such as data retrieval, linear programming, language translation, atomic codes, equipment design, large-scale customer accounting and billing, etc.

University of California
Lawrence Radiation Laboratory

Located at Livermore, California, system is used for the solution of differential equations.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal
Decimal digits/word	12
Decimal digits/instruction	12
Instructions/word	1
Instructions decoded	1
Arithmetic system	Fixed and floating point

Built-in double precision arithmetic both modes.

Instruction type	One address
Number range	$10^{-50} < N < 10^{50}$ 20 significant digits

Instruction word format

Computer	Processor
T,OP,AA,BB,MMMMM	OP,NNNNN,MMMMM

OP = Op Code
T = Tracing Digit
AA = Fast Register
BB = B-Box
M = Operand Address
N = Operand Address

SAL Assembly System is available, an algebraic compiler, all I/O Routines, and a sort-merge generator.

The LARC can have up to 99 fast accumulating registers which are also used as "B"-Boxes. In addition, the Univac LARC has a built-in multi-level indirect addressing system.

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	4	4
Mult	8	8
Div	28	28

Effective access time is zero, therefore, excluding and including access times are equal.

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential and concurrent

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Ferrite Core	97,500	1,170,000	4
Magnetic Drums (24)	6,000,000	72,000,000	68,000
Ferrite Cores	100	1,200	1

Magnetic Tape

No. of units that can be connected	40 Units
No. of chars/linear inch of tape	250 Chars/inch
Channels or tracks on the tape	8 Tracks/tape
Blank tape separating each record	1.2 or 2.4 Inches
Tape speed	100 Inches/sec
Transfer rate	25,000 Chars/sec
Start time	3.5 Millisec
Stop time	3.5 Millisec
Average time for experienced operator to change reel of tape	10-15 Seconds
Physical properties of tape	
Width	0.5 Inches

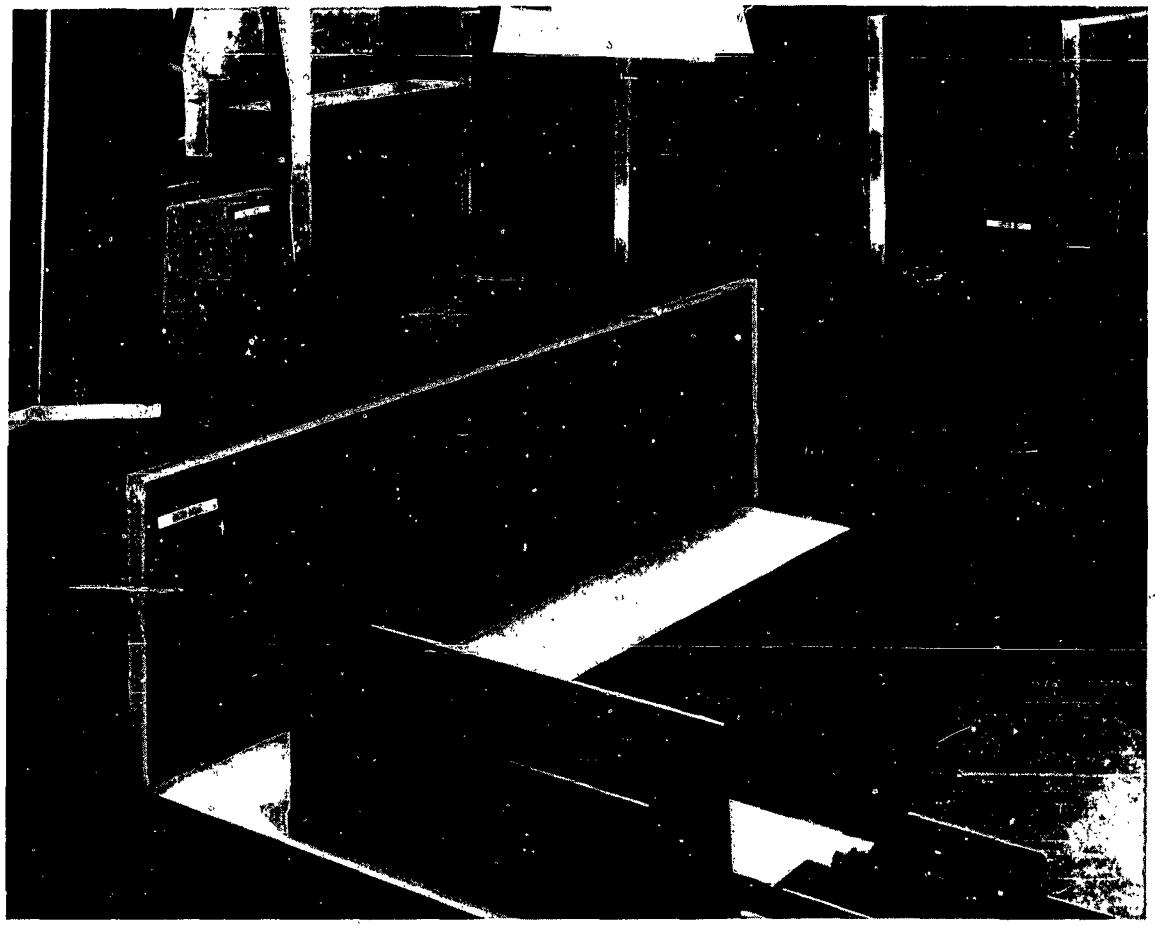


Photo by Lawrence Radiation Laboratory, University of California

Length of reel 2,400 Feet
Composition Mylar or metallic

UCRL

Media	Words	No. of Dec/Digits	Access Microsec
Core	30,000	12	4
Drum	3,000,000	12	30/word
Magnetic Tape		12	20 KC

Core memory expandable to 97,500 words
Drum memory expandable to 6×10^6 words

INPUT

Manufacturer

Media	Speed
Uniservo II	100 in/sec
Uniservo III	100 in/sec

Adequate circuits are available to handle any other desired input/output devices.

UCRL

Magnetic Tape	20 Kc/sec
6 Tape Units expansible to 40	
3 Tape units expansible to 4	
Punch Paper Tape	10 char/sec
Numeric input only	

OUTPUT

Manufacturer

Media	Speed
Uniservo II	100 in/sec
Uniservo III	100 in/sec
High Speed Printer	600 lines/min
Charactron Film Recorder	15,000 char/sec

Adequate circuits are available to handle any other desired input/output devices.

UCRL

Magnetic Tape (Uniservo II)	20 Kc
Charactron 35 mm Film	15 Kc
15 Kc alphanumeric output	
2 Kc plotting mode	
On Line Printer	600 lines/min
120 character output.	
Console Printer	10 char/sec
Alphanumeric output	

CHECKING FEATURES

Manufacturer

Automatic checking of all data transfers and all arithmetic operations.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	350 KVA	
Volume, computer	500 cu ft	

Approximate - for computer unit only

Area, computer	65 sq ft	

For compiler unit only

Room size	3,000 sq ft for system	
Capacity, air conditioner	70 Tons	

False flooring required for cold water piping.

UCRL

Power, computer 167 Kw	334 KVA	0.5 pf
Power, air conditioner	60 HP Compressor motor	
	15 HP Pump motor	
Volume, computer	33,480 cu ft	
Volume, motor generators	3,884 cu ft	
Volume, air conditioner	2,700 cu ft	
Area, computer	3,720 sq ft	
Area, motor generators	324 sq ft	
Area, air conditioner	225 sq ft	
Room size, computer	32 ft x 85 ft	
Room size, drum room	24 ft x 42 ft	
Room size, air conditioner	15 ft x 15 ft	
Floor loading	400 lbs/sq ft	
Capacity, air conditioner	60 tons, each	
	120 tons, total	
Weight, computer	115,000 lbs	
Weight, motor generators	18,000 lbs, total	

Two MG sets. One is a spare.

Weight, air conditioner	2,000 lbs, total	

Two 60 ton units. One is a spare.

Plenum ceiling for room air conditioning ducting. Concrete block building construction. The building has its own 12 KV to 440/208/120 volt substation. Substation has a transfer switch to pick up a spare transmission line. Also it has an oil disconnect switch, 750 KVA step down transformer - and a set of distribution breakers.

PRODUCTION RECORD

Manufacturer

Number produced to date	1
Number in current operation	1
Number in current production	1

COST, PRICE AND RENTAL RATES

Manufacturer

A typical basic system cost $6,000,000 or rents at $135,000/month. A basic system consists of:

1	Operator Control Console
2	Alphanumeric Console Printers
1	Engineer Control Console
2	Drum-Read Synchronizers
2	Tape Read-Write Synchronizers
1	Drum-Write Synchronizer
1	High-Speed Printer Synchronizer
1	Console Printer Synchronizer
1	Tape Position Checker Synchronizer
2	Numeric Keyboards
1	Computer
1	Processor
26	Multipurpose Fast Registers
8	Magnetic Core Storage Units (2,500 words each)
12	Magnetic Drum Storage units (250,000 words each)
4	Uniservo II Magnetic Tape Units
1	High-Speed Printer (on-line)

Maintenance cost is included in monthly rental.

PERSONNEL REQUIREMENTS

UCRL

	Three 8-Hour Shifts
Supervisors	2
Programmers	25
Engineers	18
In-Output Oper	4

Operation tends toward open shop.

Programmers are trained by being given a short general programming course on the job training with experienced senior programmer. Maintenance engineers are given six months to one year training at Remington Rand, in Philadelphia, with LARC System during construction. A minimum of 18 Maintenance Engineers is necessary for 24 hour operation (7 day). This total includes engineers to maintain associated electronic equipment being used or designed.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

UCRL

Initial Test April 1960

Time is available for rent to qualified outside organizations.

Machine presently being installed at LRL, Livermore, California.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features are ultra high computing speeds and the input-output control completely independent of computing. Due to the Univac LARC's unusual design features, it is possible to adapt any source of input/output to the Univac LARC. It combines the advantages of Solid State components, modular construction, overlapping operations, automatic error correction and a very fast and a very large memory system.

UCRL

Outstanding features include a two computer system (arithmetic, input-output processor); decimal fixed or floating point with provisions for double precision for double precision arithmetic; single bit error detection of information in transmission and arithmetic operation; and balanced ratio of high speed auxiliary storage with core storage.

Unique system advantages include a two computer system, which allows versatility and flexibility for handling input-output equipment, and program interrupt on programmer contingency and machine error, which allows greater ease in programming.

Tape will be housed in metal cabinets in an air conditioned room with proper humidity control.

Magnetic Core Storage

The core storage is divided into modular units each of which has a capacity of 2,500 words of 12 decimal digits. Four storage units are contained in a cabinet. The storage units may be added to a system in units of four up to a maximum of 39 units (10 cabinets); the equivalent of 97,500 words. Each cabinet has its own power supply, clock-pulse generator, and heat exchangers. Because of a logical limitation on the number of storage addresses available for assignment, one cabinet in a completely expanded storage system of ten cabinets would contain only three 2,500-word units.

Each storage unit contains the switching, timing, and amplifying circuits that are required for independent operation. The division of the storage into independent units permits simultaneous reference to storage: by the Computer, for obtaining instructions and for transferring operands; and by the Processor, for transfers involved in carrying out its program and for transferring data to or from the auxiliary storage or input-output. It also permits off-line maintenance to be performed on a single unit while the others are operating.

INSTALLATIONS

University of California
Lawrence Radiation Laboratory
Box 808
Livermore, California

UNIVAC SOLID STATE 80/90

MANUFACTURER

Univac Solid State 80/90

Remington Rand Univac
Division of Sperry Rand Corporation

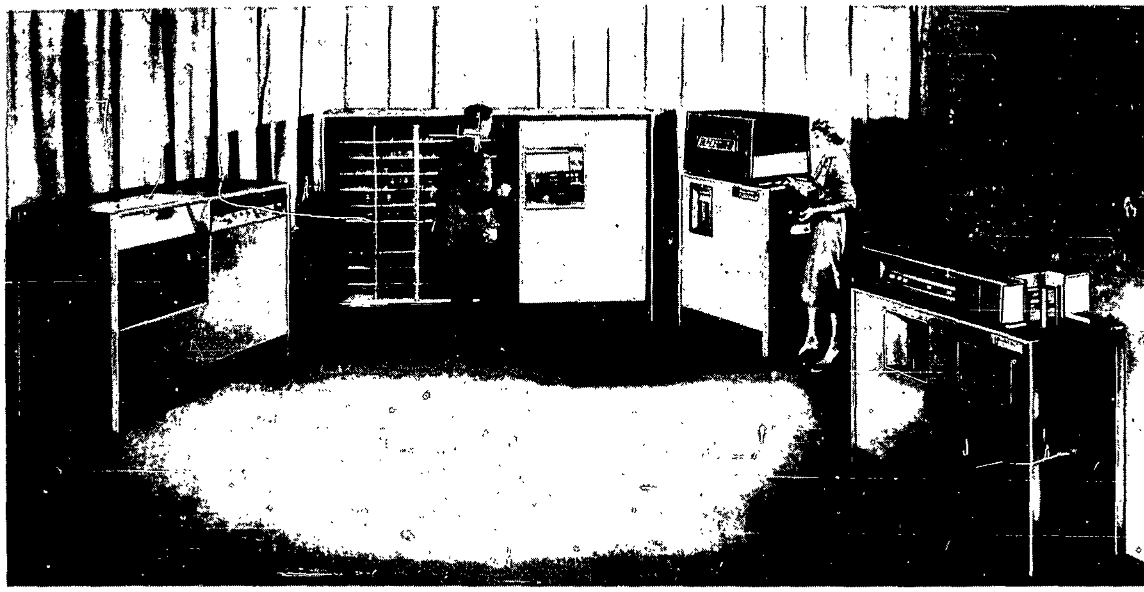


Photo by Remington Rand Univac

APPLICATIONS

Manufacturer
System is designed as a general purpose data processing system for use in general accounting, inventory, billing, budget control, sales analysis, statistics, railroad accounting, and revenue accounting, as well as scientific computing. The Univac Solid-State Computer is a medium-priced data processing system for business use. The term "Solid-State" refers to the use of Ferractor amplifiers and transistors. The Solid-State consists of a central processor, a read-punch unit, a high-speed card reader and a high-speed printer. Automatic coding techniques simplify programming. The Solid-State system may be ordered with magnetic tape units for either the 90-column system or the 80-column system.

U. S. A. Chemical Corps Biological Laboratories
Located at Fort Detrick, Maryland, USS 90 system is used for mathematical and statistical applications in matrix solution, linear regression, probit regression, analysis of variance, differential equations, numerical integration, function evaluation, etc. It is also used for comptroller functions, e.g. civilian payroll and leave, labor and material distribution, expenditure order statements, and overhead distribution.

Armed Services Technical Information Agency
Located at Arlington Hall Station, Arlington 12, Virginia, the USS 90 System is used in conjunction with the control of research and development documentation. Applications involved pertain to, request validation; inventory control and statistics; production control; document accountability; cumulative indexing of the ASTIA Technical Abstract Bulletin; and preparation of miscellaneous publications.

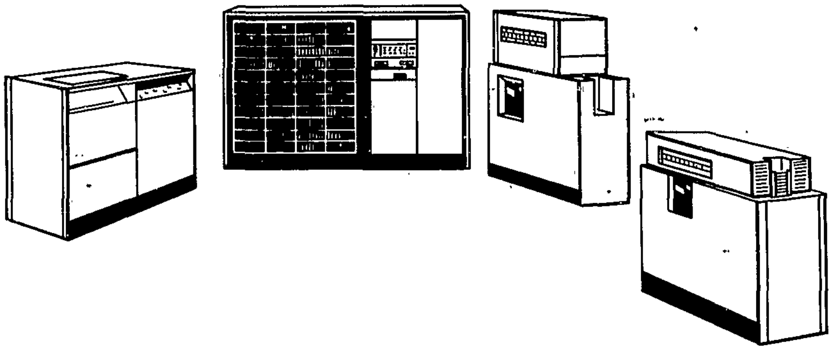
Champlin Oil and Refining Company
Located at Enid, Oklahoma, USS 80 System is used for accounting and data processing, e.g. detail ledger, payroll, gas measurement, sales analysis, and statistical reports. It is also used in technical applications, e.g. refinery materials balances, inventories, cost allocations, mass spectrometer analysis, etc.

Cook Technological Center, Division of Cook Electric Company
Located at 6401 W. Oakton St., Morton Grove, Illinois, the USS 90 is used for inventory control, job costing, payroll, trajectory studies, statistical analyses, operational systems studies, optical ray traces, radiation analysis, and probability theoretical analysis.

Douglas Aircraft Company
Located at Charlotte, North Carolina, the system is used for general accounting, labor distribution, cost and expense ledgers, material, and payroll.

Mason & Hanger-Silas Masor Co., Inc.
Located at Burlington, Iowa, USS 90 is used for payroll and all related reports, labor cost distribution, material cost distribution, inventory control and purchase requisitions, production reporting for A.E.C. activities, personnel reporting, document control, and production inventories.

Shell Development Company
Located at 3747 Bellaire Blvd., Houston, Texas, USS 80 is used for scientific calculations in reservoir engineering and mechanical engineering.



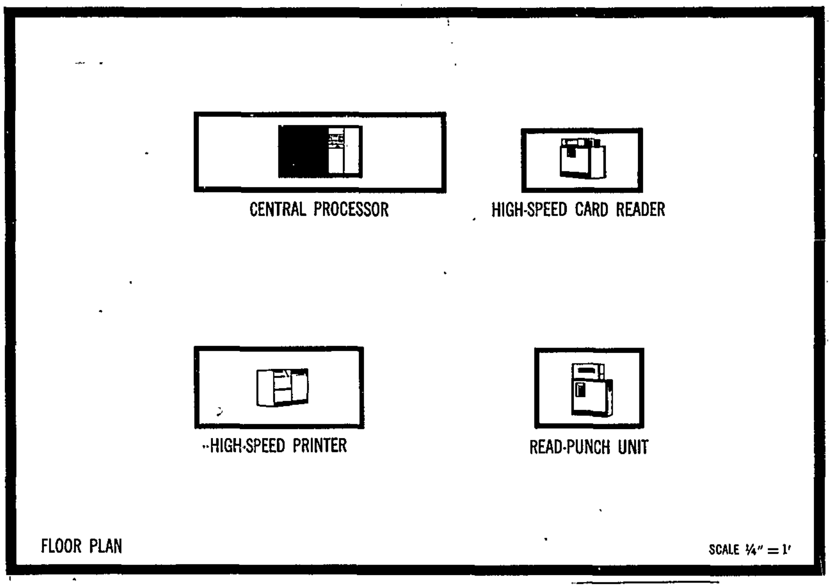


Photo by Remington Rand Univac

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Biquinary coded decimal
Decimal digits/word	10 plus sign
Decimal digits/instruction	10 (sign not used)
Instructions/word	1
Instructions decoded	53
Arithmetic system	Fixed point
Instruction type	One and a half address

One address is the operand - the half address refers to the address of next instruction to be executed. Next instruction is the (c) portion of the instruction.

Number range -9999999999 to +9999999999

Instruction word format

Instruction Code	(m) Address	(c) Address

(m) Address is address of operand
(c) Address is the address of the next instruction to be executed

A sizable number of precoded routines are supplied to Solid Stated Computer users. Approximate 58 routines available for 80 column tape system, and 62 available for 90 column tape system.

Automatic coding includes an X-6 assembly available for card and tape system.

Registers and B-boxes

3 - 10 digit arithmetic registers are included in the design.

3 - index registers (4 digits each) are optionally available.

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	1,360	85
Mult	1,275	
Div	1,275	

Multiply time calculation - 5 word time plus no. of multiplier digits plus sum of these digits (min. 119 microseconds, max. 1,785 microseconds).

Central Processor and High-Speed Reader

Photo by Mason & Hanger-Silas Mason & Co., Inc.

Divide time - 5 word time plus 2 times number of digits in quotient plus the sum of the odd digit positions in the quotient plus the sum of the tens complement of the even digit-positions in the quotient. 425 microseconds min., 1955 microsec. max.

Average access time is used in above table. Operands and results are assumed stored in high speed access portion of the drum. Word time is 17 microseconds.

Construction (Arithmetic unit only)

Vacuum tubes	20
Transistors	700
Condenser-Diodes	23,000
Magnetic Amplifiers (Ferractors)	3,000

Arithmetic mode	Serial by digit
	Parallel by bit
Timing	Synchronous
Operation	Concurrent

The "Including Storage Access" add, multiply, and divide times include the time necessary for accessing the two operands and the result address.

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Drum	4,000	40,000	1,700 (avg)
Drum	1,000	10,000	425 (avg)
Drum Mass Memory (per unit)	2,304,000 plus signs	over 24,000,000 incl signs	385

Up to 10 drum units are possible.

Magnetic Tape

No. of units that can be connected	10 Units
No. of chars/linear inch of tape	250 Char/inch
Channels or tracks (8 incl sprocket)	7 Tracks/tape
Blank tape separating each record	1.05 Inches
Tape speed	100 Inches/sec
Transfer rate	25,000 Char/sec
Start time	12 Millisec
Stop time	9 Millisec
Average time for experienced operator to change reel of tape	30 Seconds

Photo by Armed Services Technical Information Agency

Physical properties of tape

Width	0.5015+0.0000-0.0030 Inches
Length of reel (Recording surface)	2,500 Feet
Composition	Mylar

All users have the 5,000 word drum. Standardized system comparison for formula $[(A+B)\cdot C]/D \rightarrow$ Memory requires 1.19 milliseconds.

INPUT

Manufacturer

Media	Speed
High Speed Card Reader	450 cards/min
Read-Punch Card Unit	150 cards/min
Magnetic Tape	100 inches/sec

No plugboard is used. 80 or 90 column card units are available. Tape densities and formats are compatible with other Univac tape systems.

USA CCBL

Read Punch Unit	150 cards/min
High Speed Reader	450 cards/min

ASTIA

Punched Cards (90 col.)	450 cards/min
Punched Cards	150 cards/min

Punch unit also has capability to read as well as punch.

Champlin

Media	Speed
Punched Cards (80 col.)	450 cards/min

Cook

High Speed Reader	450 cards/min (90 col/card)
Read-Punch Unit	150 cards/min (90 col/card)

Douglas

Read-Punch	150 cards/min

Mason

Read-Punch Unit	150 cards/min
High Speed Reader	450 cards/min

Above units are buffered to the system and can be utilized singularly or together.

Shell

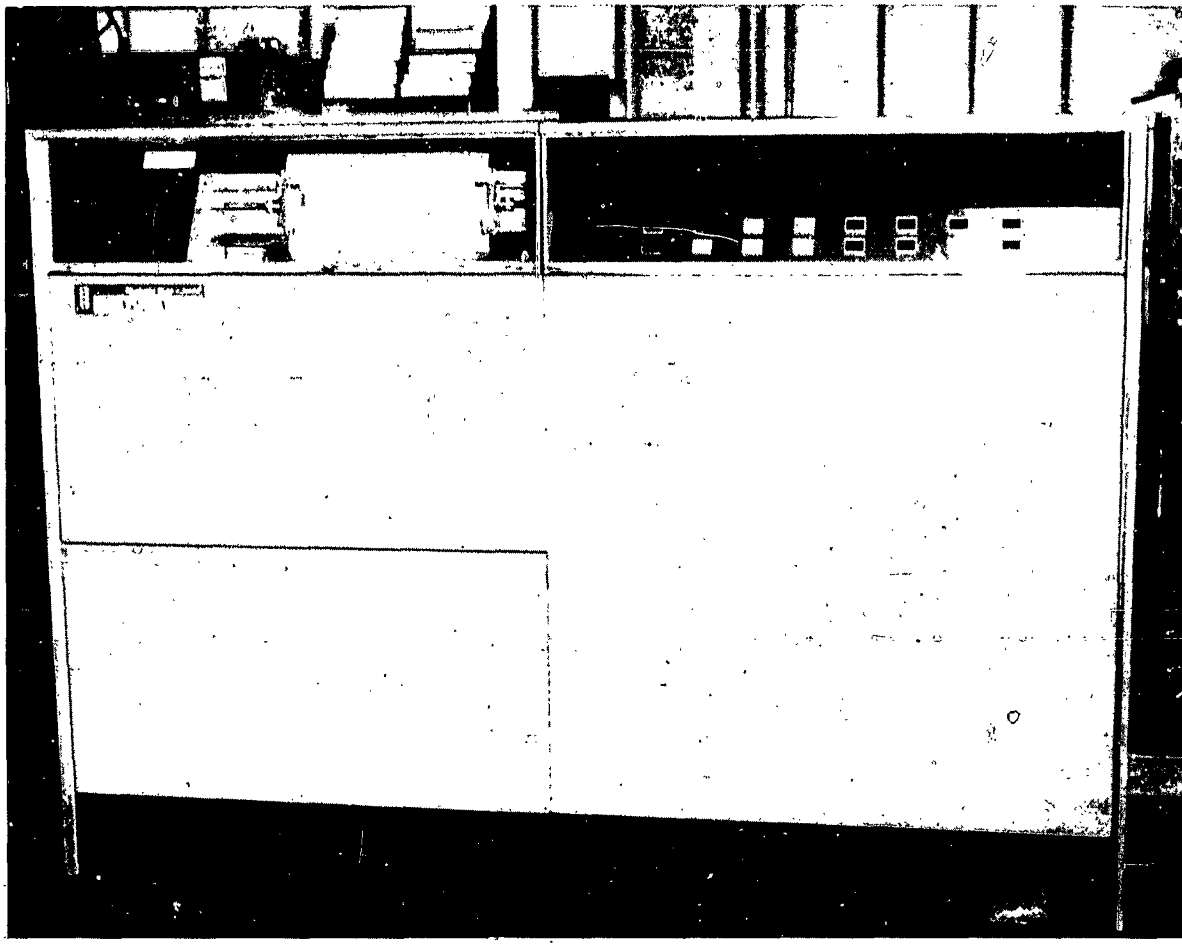
Cards (80 column)	450 cards/min

OUTPUT

Manufacturer

Media	Speed
Read-Punch Card Unit	150 cards/min
Magnetic Tape	100 inches/sec
High Speed Printer	600 lines/min
Card Punching Printer	150 cards/min

Printer prints 130 char/line. Card Punching Printer prints on both sides of Tab Card - a maximum of 13 lines on a side. Instantaneous printing rate is 900



High Speed Printer

Photo by Mason & Hangar - Silas Mason Co., Inc.

lines/minute.

USA CCBL

Media	Speed
Read Punch Unit	150 cards/min
High Speed Printer	600 lines/min

ASTIA

Media	Speed
Punched Cards (90 col.)	150 cards/min
Printer	600 lines/min

Punch unit also has capability to read as well as punch.

Champlin

Media	Speed
Printer	600 lines/min
Punched Cards (80 col.)	150 lines/min

Cook

Media	Speed
Read-Punch Unit	150 cards/min (90 col/card)
High Speed Printer	600 lines/min (130 dig/line)

Douglas

Media	Speed
Printer	600 lines/min

Mason

Media	Speed
High Speed Printer	600 lines/min
Read-Punch Unit	150 cards/min

Above units can be used singularly or together. Utilization of punch with printer will slow speed considerable, dependent on punching requirements. 130 sectors of printing.

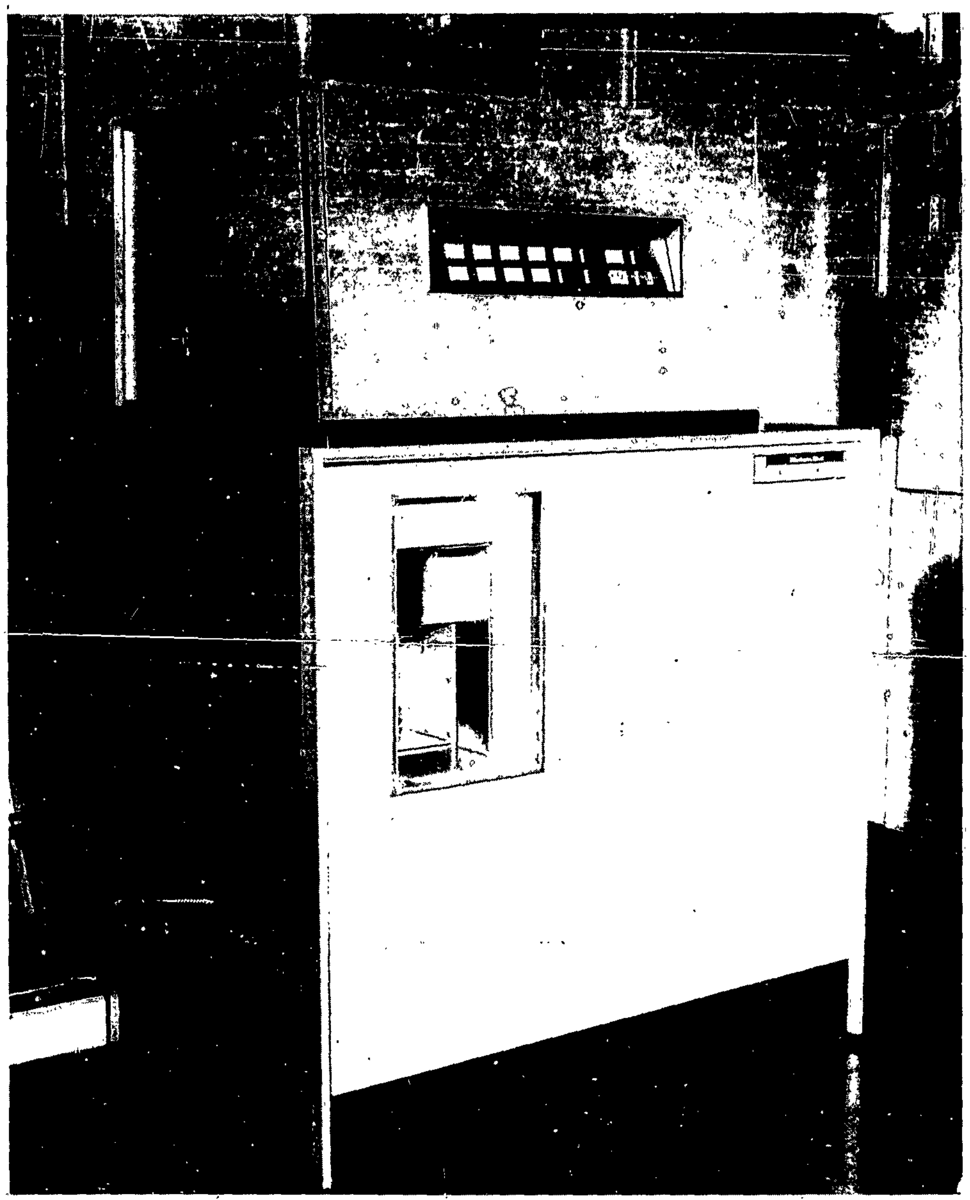
Shell

Media	Speed
Cards	150 cards/min
Line Printer	600 lines/min

80 column cards are used.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Manufacturer
Tubes	20	Processor
	-	Read-Punch
	-	Reader
	144	Printer
	22	Synchronizer
	29	Servo
	215	
Diodes	23,000	Processor
	550	Read-Punch
	545	Reader
	500	Printer
	11,900	Synchronizer
	10	Servo
	36,505	



Read-Punch Unit

Photo by Mason & Hangar - Silas Mason Co., Inc.

Type	Quantity	
Transistors	700	Processor
	12	Read-Punch
	37	Reader
	2	Printer
	168	Synchronizer
	-	Servo
	919	

CHECKING FEATURES

Manufacturer

Odd parity, overflow, complete tape read checks. Two read stations in card equipment. Logical checks in central processor and printer.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	48.2 KVA	0.8 pf
Area, computer	925 sq ft	
Capacity, air condition	11.8 Tons	
Weight, computer system	12,027 lbs, total, incl 2 magnetic tape units	

Cable duct work is supplied with computer, if desired. No special flooring is required. Power includes printer, punch, reader and 10 servos.

USA CCBL

Power, computer	13.52 Kw	16.9 KVA	0.8 pf
Power, air condition	33 Kw	33 KVA	1 pf
Volume, computer		297 cu ft	
Volume, air conditioner		80 cu ft	
Area, computer		576 sq ft	
Area, air conditioner		18 sq ft	
Room size		28 ft x 17 ft	
Capacity, air conditioner		5 Tons	
Weight, computer		7,237 lbs	
Weight, air conditioner		1,000 lbs	

Installation of 5 ton air conditioner. Power line from transformer in basement to computer room. Air conditioner is in addition to building air conditioner.

ASTIA

Power, computer	16 Kw	14.4 KVA
Volume, computer		3,180 cu ft
Area, computer		530 sq ft
Room size		1,060 sq ft
Floor loading		118.4 lbs/sq ft
		473.6 lbs concen max
Weight, computer		7,237 lbs

Building - Temporary government structure.

Floor - Raised in area where data processing equipment is located.

Walls - Partitioned with glass panels for equipment viewing.

Champlin

Power, computer	15 KVA
Volume, computer	8,400 cu ft
Volume, air conditioner	60 cu ft
Area, computer	840 sq ft
Area, air conditioner	20 sq ft
Room size	30 ft x 28 ft
Capacity, air conditioner	5 Ton
Weight, computer	8,000 lbs
Weight, air conditioner	500 lbs

30 x 28 ft room prepared by combining three separate rooms. Space provided also includes space required for four tape units and tape synchronizer to be installed later.

Cook

Power, computer	12 Kw	15 KVA	0.8 pf
Volume, computer		340 cu ft	
Area, computer		275 sq ft	
Room size		575 sq ft	
Floor loading		24 lbs/sq ft	
		3,064 lbs concen max	
Weight, computer		6,500 lbs	

No special site preparation requirements.

Douglas

Power, computer	15 KVA
Power, air conditioner	7.5 KVA
Volume, computer	600 cu ft
Volume, air conditioner	60 cu ft
Area, computer	120 sq ft
Area, air conditioner	10 sq ft
Room size, computer	30 ft x 20 ft
Room size, air conditioner	6 ft x 6 ft
Floor loading	150 lbs/sq ft
	3,500 lbs concen max
Capacity, air conditioner	5 Tons
Weight, computer	6,200 lbs
Weight, air conditioner	900 lbs

Six inch raised false floor to provide for power cables. Exhaust-diffusers installed in ceiling for heat dissipation/air conditioning. Power is single phase, 3-wire, 240 volt system.

Mason

Power, computer	16.32 Kw	14.4 KVA	0.85 pf
Power, air condition	11 Kw		0.85 pf
Volume, computer		296.9 cu ft	
Volume, air conditioner		120 cu ft	
Area, computer		58.1 sq ft	
Area, air conditioner		15 sq ft	
Room size, computer		530 sq ft	
Room size, air conditioner		20 sq ft	
Floor loading		124.5 lbs/sq ft	
		147.1 lbs concen max	
Capacity, air conditioner		10 Tons	
Weight, computer		7,237 lbs	
Weight, air conditioner		1,985 lbs	

No site preparations required except to electrical distribution. Building is brick construction with concrete and asphalt flooring. Two single phase 210 volt regulators were installed for power requirement control.

Shell

Power, computer	14.5 KVA
Volume, computer	318 cu ft
Area, computer	62 sq ft
Room size	20 ft x 25 ft
Weight, computer	6,425 lbs

Single phase, 220 volt, 70 ampere, 60 cycle, AC power.

PRODUCTION RECORD

Manufacturer

Number in current operation	190
Number on order	300
Time required for delivery	12 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Cost	Monthly Rental
Card System 80 or 90 Column		
1 Central Processor	$234,215	$4,685
1 Read-Punch Unit	48,650	975
1 Card Reader	15,290	305
1 Printer on-line	49,345	985
Basic Type -Card System (80 or 90 Col.)		
1 Central Processor (w/3 Index Reg)	$241,715	$4,835
1 Magnetic Tape Synchronizer	50,000	1,000
2 Magnetic Tape Unit (ea 20,000/450)	40,000	900
1 Read-Punch Unit	48,650	975
1 Card-Reader	15,290	305
1 Printer on-line	49,345	985
Additional Equipment		
Card System		
3 Index Registers	$ 7,500	$ 150
1 Printer Off-Line	195,000	3,500
Tape-Card System		
1 Card Punching Printer	125,000	2,700
1 Printer Off-Line	195,000	3,500

Up to max. 10 tape units at 20,000/450 each.

A service cintract is available.

USA CCBL

Central processor cost $234,587.87.

Read Punch Unit, High Speed Reader, High Speed Printer rents for $2,265/monthly.

Maintenance service contracting is $13,000/year.

ASTIA

Rental rates for basic system

	Monthly Rental
Type 7909	$4,835
Type 7904	305
Type 7910	975
Type 7901	985

Rental rates for additional equipment

Tape Synchronizer	$1,000
Randex Drum Unit	1,500
Randex Control Unit	2,000
Tape Uniservo	450 each
Unityper	30 each

Champlin

Central processor, reader, read-punch, and printer make up basic system. Sales price $347,000.

Tape Synchronizer - 4 tape units - price not available (not now installed)

The above system rents for $7,100 per month.

Tape equipment rents for $2,900 per month.

Service on all equipment is included in above rental rates.

Cook

The 7900 Series Central Processor, High-Speed Reader, High-Speed Printer, and Read-Punch Unit cost $450,000 and rents at $6,900/month.

The Sorter, Verifier, Collator, Interpreter, and Key punch cost $15,000 and rents at $400/month.

Douglas

Rental rate for processor, card read-punch, and printer is $8,000/month.

Maintenance service contracting is included in rental.

Mason

Rental rates for additional equipment

2 Electronic Collators	$ 125
1 Reproducing Collator	170
2 Alpha-punches	55
1 Verifier	60
1 Interpreter	105
1 420 Electronic Sorter	85
1 421 Electronic Sorter	100

Shell

Central processor, high speed printer, high speed reader, and read punch unit rents for $7,100/month.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	2	2	3
Analysts	A supervisory function		
Program-Coders	5	5	5
Clerks	3	3	3
Librarians	1	1	1
Operators	2	4	6
Engineers	1	1	1
Technicians	1	2	3

Programming course supplied on regional basis.

USA CCBL

	One 8-Hour Shift Used	Recommended
Supervisors	4	
Programmers	5	8
Operators	3	3
Technicians	1	1

Methods of training used includes formal courses in machine operation and programming and on-the-job training.

ASTIA

	One 8-Hour Shift
Supervisors	2
Analysts	1
Programmers	3
Librarians	1
Operators	1
In-Output Oper	1

Operation tends toward closed shop.

Programming course conducted by contractor followed up with on-the-job training.

Champlin

	One 8-Hour Shift Used	Recomm	Two 8-Hour Shifts Used	Recomm
Supervisors	1	1	2	2
Analysts	2	2	4	4
Programmers	4	4	8	8
Operators	1	1	2	2
In-Output Oper	1	1	2	2

Operation tends toward open shop.

All personnel directly and indirectly connected with programming and operation attended four week machine logic training course conducted by Remington Rand Training Department.

Cook

	One 8-Hour Shift Used	Recommended
Supervisors	2	2
Programmers	5	5
Operators	2	2
Engineers	2	2

Operation tends toward open shop.

Schooling provided by Remington Rand both in Chicago and at Purdue University, Lafayette, Indiana.

Douglas

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	1
Operators	1

Operation tends toward open shop.

Two week course followed by on-the-job training.

Mason

	One 8-Hour Shift
Supervisors	1
Programmers	1
Coders	1
Clerks	3
Operators	3
In-Output Oper	3

Operation tends toward open shop.

Methods of training used are customer training and seminar schools and on-the-job training.

Shell

	One 8-Hour Shift
Supervisors	1
Programmers	3
Clerks	1
Operators	1
Engineers	1

Operation tends toward open shop.

Methods of training used includes formal lectures and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

A preventive maintenance check is made by service engineer at start of each working day.

USA CCBL

Time is available for rent to qualified outside organizations.

System is presently being used one full shift plus four hours overtime per day.

ASTIA

Good time 30 Hours/Week (Average)

Above figure based on period 15 Feb 60 to 31 May 60

Passed Customer Acceptance Test 13 Feb 60

Time is not available for rent to outside organizations.

Champlin

Time is not available for rent to outside organizations.

Computer installed 11 March 1960.

Cook

Good time 35 Hours/Week (Average)

Attempted to run time 40 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.875

Above figures based on period 1 Jun 60 to 31 Jul 60

Passed Customer Acceptance Test 31 Dec 59

Time is available for rent to qualified outside organizations.

Douglas

Average error-free running period 1 Week

Good time 40 Hours/Week (Average)

Attempted to run time 40 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.97

Above figures based on period from Jun 60 to Sep 60

Passed Customer Acceptance Test Jun 60

Time is available for rent to outside organizations.

Mason

Time is not available for rent to outside organizations.

Computer was accepted three months ago. Reliability in past two months has been better than 90%.

Shell

Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features are simultaneous operations, namely, card reading, card punching, printing, tape read or write, compute. All input-output units are buffered. Card punching printer provides the ability to punch a card and print on both sides of the same card. Punching is verified.

ASTIA

Outstanding features include an extremely low heat output and operates at maximum 100°F and a minimum of 60°F.

Unique system advantages are extreme versatility - basic punched card input-output is small scale system, yet addition of drives and random access storage will place it in medium scale category, and bit-by-bit logic permitted simple solution to problem of representing some 240 need-to-know categories plus user code, security clearance, VIA code and user category in one punch card for each user-contract combination.

Mason

Outstanding features include flexibility over conventional printers, reliability and no plug boards: programs are loaded directly on the drum.

Unique system advantages include reduction operator processing, enabling printing of reports and punching of summary cards simultaneously, and tightening of control in hands of supervision.

Card storage racks are in a large walk-in vault, the bell system replaced the sprinkler system, and temperature and humidity are controlled by air-conditioning.

Subject installation was added to replace a UNIVAC 120 System which required a number of additional tabulating equipment for support. The new system enabled a considerable reduction in supporting equipment and personnel while allowing greater control and flexibility of operations. Process of changing existing procedures over to new system is about completed.

FUTURE PLANS

USA CCBL

Purchase or rental of Index Registers and Magnetic Tape Units is planned.

ASTIA

The addition of tape equipment and randex units are planned. The addition of these units will provide the capability to add the following applications:

Information search and retrieval
Document Identification
Document Destruction Control
Bibliography Compilation and Print Out.

Mason

Maintenance scheduling and control procedures are being discussed and formulated for application on the new system.

Engineering problems are in the programming stage to enable the production of punched tape to be used in conjunction with numerical control tape operated production machines.

Shell

Anticipate addition of magnetic tapes, i.e. a tape synchronizer and 2 to 5 tape units.

Kaiser Steel Corporation anticipates installation of UNIVAC Solid State 80 System.

INSTALLATIONS

U. S. Army Chemical Corps Biological Laboratories
Fort Detrick, Maryland

Armed Services Technical Information Agency
Arlington Hall Station
Arlington 12, Virginia

Champlin Oil and Refining Company
P. O. Box 552
Enid, Oklahoma

Cook Technological Center
Division of Cook Electric Company
6401 West Oakton Street
Morton Grove, Illinois

Douglas Aircraft Company
3000 Ocean Park Blvd.
Santa Monica, California

Mason and Hanger-Silas Mason Co., Inc.
Box 561, Iowa Ordnance Plant
Burlington, Iowa

Chase Manhattan Bank (SS 80)
57 William Street, Room 200
New York, N. Y.

Purdue University (SS 80)
Computing Laboratory ENAD
W. Lafayette, Indiana

Shell Development Company
E and P Research, Computing Section
3747 Bellaire Blvd.
Houston, Texas

North Carolina State College
Raleigh, North Carolina (SS 80 Proposed)

Southern Methodist University (SS 90)
Dallas 22, Texas

ADDITIONAL REMARKS

	Weights (Shipping) Lbs	Heat Dissipation	Air Conditioning (Approx. Tons)
Card Reader	815	3,396 BTU/hr	.27
Card Punch 80 Col.	1,120	3,396 BTU/hr	.27
Card Punch 90 Col.	1,420	3,780 BTU/hr	.32
Printer	1,720	11,910 BTU/hr	1.0
Processor	3,760	27,660 BTU/hr	2.3
Tape Synchronizer	2,980	13,020 BTU/hr	1.1
Tape Unit (each)	758	8,160 BTU/hr	.68

Random Drum Units and Card Punching Printer are also available.

UNIVAC STEP

Univac Solid State STEP Card and STEP Tape Systems

MANUFACTURER

Remington Rand Univac Division
Sperry Rand Corporation

Photo by Sperry Rand Corporation

APPLICATIONS

General purpose data processing system designed for general accounting, inventory, billing, budget control, sales analysis, and statistics, as well as scientific applications.

The Univac Solid State STEP System (Simple Transition Electronic Processing) is a modular version of the Solid State 80 and 90 System. STEP offers speed, accuracy, and economy of the Univac Solid State Computer to the user not requiring the full capabilities of the larger system. STEP is available to either the 80 or 90 column card user. Magnetic tapes, Randex Drum Unit and card punching printer are also available.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	10 plus sign
Decimal digits/instruction	10 (sign pos. not used)
Instructions/word	1
Instructions decoded	53
Arithmetic system	Fixed point

Add, subtract, multiply, and divide

Instruction type — One and one-half address

One address refers to the operand or (m) portion of the instruction word. The half address refers to the address of the next instruction to be executed. Next instruction address is given in the (c) portion of the instruction word.

Number range — -9999999999 to +9999999999

Instruction word format

Instruction Code		m				c			

(m) address is address of operand
(c) address is address of the next instruction to be executed

A basic package of input-output and test routines are supplied to all STEP users. None are built in.
Automatic coding
X-6 Assembly System
Registers and B-boxes
Three 10 digit arithmetic registers are included in all models. Three index registers (4 digits each) are available on all STEP Tape Systems and are optional on the STEP Card Systems.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	1,360	85
Mult	1,275 plus	

Average access time was used, also assumed operands and results were stored in high speed access portion of drum.

Div	1,275 plus	

Access time includes accessing 2 operands and result address.

Calculation of multiply time in word times is the sum of 3 factors. Five word times, plus the number of multiplier digits, plus the sum of the multiplier digits - Min. time 119 microseconds. Maximum time 1,785 microseconds.

Divide time expressed in word times is calculated as follows: five word times, plus twice the number of digits in the quotient, plus the sum of the odd digit positions in the quotient, plus the sum of the tens complement of the even digit - positions in the quotient. Minimum time 425 microseconds. Maximum time 1,955 microseconds.

Construction (Arithmetic unit only)

Vacuum-tubes	20
Transistors	700
Condenser-diodes	23,000
Ferractors (Magnetic Amplifiers)	3,000

Arithmetic mode Serial by digit, parallel by bit
Word time is 17 microseconds.
Timing Synchronous
Operation Concurrent

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Drum (Fast Memory)	2,400 Basic	24,000	1,700

Additional fast memory can be specified in increments of 4,000 digits up to a maximum of 16,000 digits. Maximum fast memory available on one processor is 40,000 digits.

Drum (High Speed Memory)			425

First 2,000 digits (200 words) of high speed memory is a prerequisite to additional high speed memory and/or additional fast memory. Additional high speed memory can be specified in increments of 2,000 digits up to a maximum of 8,000 digits. Maximum high speed memory of any one processor is 10,000 digits.

Drum Mass Memory	2,304,000(min)	24,000,000 incl. signs	385,000
(Randex Drum) optional	23,040,000(max)	240,000,000 incl. signs	(Avg)

Magnetic Tape

No. of units that can be connected	10 Units
No. of char/linear inch of tape	250 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	1.05 Inches
Tape speed	100 Inches/sec
Transfer rate	25,000 Char/sec
Start time	12 Millisec
Stop time	9 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width (+.000 -.003)	0.5015 Inches
Length of reel	2,500 Feet
Composition	Mylar

INPUT

Media	Speed
High Speed Card Reader	450 cards/min
Read-Punch Card Unit	150 cards/min
Magnetic Tape	100 in/sec
	25,000 pulses/sec

Tape densities and formats are compatible with other Univac tape systems. 80 or 90 column cards may be used (no plug-boards).

OUTPUT

Media	Speed
Read-Punch Card Unit	150 cards/min
Magnetic Tape	100 in/sec
	25,000 pulses/sec
High Speed Printer	600 lines/min
	130 char/line possible
Card Punching Printer	150 cards/min

Card Punching Printer prints on both sides of tab card. A maximum of 13 lines on a side. Instantaneous printing rate is 400 lines/min. (Optionally available on either the 80 col. card or 80 col. tape systems. Not available on 90 col. systems).

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type		Quantity	Use
Tubes			
		20	Processor
		--	Read-Punch Unit
		--	Card Reader
		144	H. S. Printer
		22	Synchronizer
		29	Servo Unit
	Total	215	
Diodes			
		23,000	Processor
		550	Read-Punch Unit
		545	Card Reader
		500	H. S. Printer
		11,900	Synchronizer
		10	Servo Unit
	Total	36,505	
Transistors			
		700	Processor
		12	Read-Punch Unit
		37	Card Reader
		2	H. S. Printer
		168	Synchronizer
		--	Servo Unit
	Total	919	

CHECKING FEATURES

Odd parity, arithmetic overflow, complete magnetic tape. Checks - card equipment has 2 read stations; punch unit has a post read station for checking card punching. Central processor and printer design include logical checks.

COST, PRICE AND RENTAL RATES

	Cost	Monthly Rental
Sale Price of basic STEP Card System (80 or 90 col.)	$175,000	$3,500
Price includes -		
Central Processor (24,000 digits of fast memory)		
High Speed Card Reader 450 cards/min.		
Read-Punch Unit 150 cards/min.		
High Speed Printer 600 lines/min. w/a 100 printing positions		
Registers A, X.L.		
Sale Price of basic STEP Tape System (80 or 90 col.)		
Basic units listed above plus the following -	$175,000	$3,500
Tape Synchronizer 8	50,000	1,000
Uniservo II Tape Units (maximum 10)	each 20,000	450
Index Registers (3)	7,500	150
Sale Price of Additional Equipment		
Multiply and Divide Feature	20,000	400
Pre and Post Reading Station on Punch Unit and Stacker Select on Card Reader and Punch	15,000	300
Additional Print Positions for High Speed Printer		
30 Additional Print Positions	2,500	50
Available in increments of 20 positions	1,500	30
Available in increments of 10 positions	1,000	20
600 cards/min. speed for Card Reader	10,000	200
Index Registers (3) Card System option	7,500	150
Additional Memory		
First 2,000 digits of High Speed Memory	22,500	450
Each additional increment of High Speed Memory (2,000 digits) (maximum 10,000 digits per system)	15,625	312.50
Each additional increment of Fast Memory (4,000 digits) (maximum 40,000 digits per system)	12,000	250
First 2,000 digits of High Speed Memory is a prerequisite to additional High Speed Memory and/or additional Fast Memory.		
Randex		
Includes: Randex Drum Unit (24 million digits) Power Control Unit	$166,850	$3,550
Additional Randex Drum Units (24 million digits) This price is for each additional drum unit up to a total of 4 (96 million digits). Prices on units in excess of 4 up to a total of 9 will be quoted on request.	each 89,300	1,900
Synchronizer Randex requires a synchronizer. When specified with a tape system, Randex will be under the control of the tape synchronizer. No additional synchronizer is required. When Randex is specified for use with a card system, a synchronizer must be included.	50,000	1,000
Card-Punching Printer An on-line card punching printer is available for 80 column systems.	125,000	2,700

Maintenance included in rental contract. Service contract available to STEP System purchasers.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer (card system) 16.9 KVA 0.8 pf
(Reader, punch, printer and processor)
Power, computer (tape system)
Add 7.0 KVA for synchronizer and first tape unit
Add 2.5 KVA for each additional tape unit

Volume, processor	144 cu ft
Volume, reader	24 cu ft
Volume, punch	36 cu ft
Volume, printer	64 cu ft
Area, processor	24 sq ft
Area, reader	6 sq ft
Area, punch	6 sq ft
Area, printer	16 sq ft
Floor loading, processor	146.8 lbs/sq ft
reader	91.8 lbs/sq ft
punch	134.0 lbs/sq ft
printer	96.5 lbs/sq ft

Common base available for processor.
Capacity, air conditioner 5 Tons
Tonnage required to compensate for machine heat only.
Weight, computer 7,162 lbs
Cable duct work is supplied with computer, if desired. No special flooring required.

PRODUCTION RECORD

Number produced to date	200
Number in current operation	175
Time required for delivery	9 months

PERSONNEL REQUIREMENTS

Personnel requirements depend upon the operation and application involved - whether it is one large volume application or several small ones, etc.

Programming course supplied on a regional basis.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

A preventive maintenance check is made by a service engineer at the start of each working day.

ADDITIONAL FEATURES AND REMARKS

Outstanding features are modular design. All input-output units are buffered, including Randex availability of card punching printer.

Instruction List and Programming Aids

Instruction Format

The Univac Solid-State Computer employs a one and one-half address instruction code system, with one instruction per processor word. Each instruction word is written in ten decimal digits and consists of an operation code, the address of the operand, and the address of the next instruction. The leftmost digit position is considered the most significant digit (MSD) and the rightmost digit position is considered the least significant digit (LSD).

The leftmost two digits are the operation code (OC), which tells the processor the arithmetic or logical operation to execute. The next four digits, the m portion, supply the address of the operand, which is usually the address of a word in storage. The remaining four digits, termed the c address, are the location of the next instruction. The m and c addresses may have different significance for some special instructions, as noted in the instruction definitions.

Instruction Cycle

The instruction cycle - the steps the processor takes in executing a command - usually occurs in four phases. (In a few instructions, there is no search for the operand.) The duration of a phase is measured in units called word times. A word time is that interval in which the drum revolves one word under the read-write heads - in the Univac Solid-State Computer, 0.017 milliseconds. The four phases are:

(1) Staticize the Instruction:
The instruction located by the previous search (4) is transferred from the drum location to the static register (operation code only) and register C (the entire word). This step requires one word time.

(2) Search for the Operand:
If the m address part of the instruction does not refer to a drum storage location or a register, this step is ignored and no time is required. If it does refer to a drum location, the address of the next available storage location on the drum is compared with the first address part of the contents of register C every word time until a match is obtained. Register C contains the entire instruction. This step requires a minimum of one word time and a maximum of 200 word times.

(3) Execute the Instruction:
The operation indicated in the instruction is performed. The time required for this phase depends upon the type of operation to be performed.

(4) Search for the Next Instruction:
The address of the next available storage location on the drum is compared with the second address part of the contents of register C until a match is obtained. This step requires a minimum of one word time and a possible maximum of 200 word times.

UNIVAC I
Universal Automatic Computer Model I

MANUFACTURER
Remington Rand Univac
Division of Sperry Rand Corporation

Photo by Franklin Life Insurance Company

APPLICATIONS

Manufacturer
General purpose large scale digital computing.

Army Map Service
Located in Erskine Hall, Army Map Service, the system is used for Geodesy photogrammetry, and mapping computations, including, e.g. special map projections and coordinate systems, least square adjustments of triangulation, traverse computation and adjustment, transformation of rectangular and geographic coordinates, analytic adjustment of aerial photographic strips and blocks, satellite orbit computations, geodetic and mathematical tables, and star occultation computations.

U. S. Navy David Taylor Model Basin
Located at the David Taylor Model Basin, Carderock, Md., the system is used for the solution of naval engineering problems, solution of naval logistics problems, and for financial management analysis.

Air University, Maxwell AFB, Alabama
Located at Montgomery, Alabama, the system is used for data processing of all educational record keeping involved in administering 336,000 correspondence students enrolled under the auspices of the Air University Extension Course Institute and for statistical reports and analysis of 113,000 Air Force officer jobs and records to aid the Air Force Educational Requirement Board determine qualitative, college level, educational needs for Air Force officers.

Bureau of the Census, Washington 25, D.C.
Located in Washington, D.C., the system is used for statistical data processing for current surveys of foreign trade and other programs of the Bureau of the Census and for service work for other Federal agencies, involving editing and rearranging of input, sorting and merging of records, tallying, tabulating, and summarizing data, computing percentages, medians, means, weights, variances, etc. for data, and arrang-

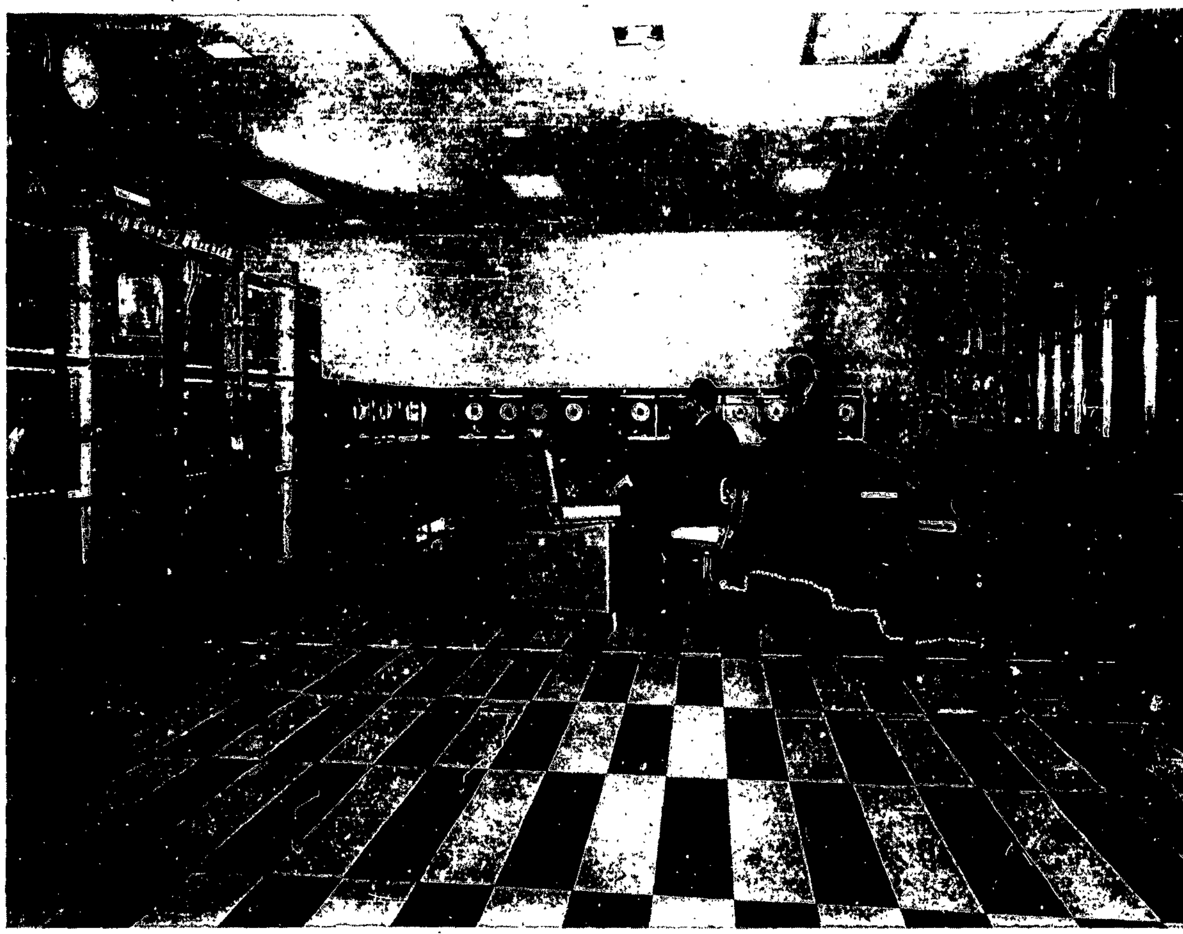


Photo by Franklin Life Insurance Company

ing and preparing tables, listings, labels, etc. for high speed printer.

Internal Revenue Service Statistics Division
Located in Suitland, Maryland (U. S. Dept. of Commerce, Bureau of the Census), the system is used for data edit, sort, merge, and compilation of statistical data for statistics of income publications on economic aspects of business and individual income tax returns.

The Chesapeake & Ohio Railway Company
One computer located at 400 Terminal Tower, Cleveland 1, Ohio and another at Case Institute of Technology, Cleveland, Ohio, they are used for payroll, freight revenue accounting, private line car accounting, and stockholder records.

The Franklin Institute Computing Center
Located at separate facilities in building housing Science Museum and Laboratories for Research & Development, the system is used as a service bureau. Being a service bureau, the nature of the workload is constantly changing. During the three and one-half years of operation we have handled almost every conceivable type of mathematical and data processing application. As a general rule, individual research, engineering and mathematical projects have numerically exceeded straight data processing jobs while the greater overall volume of machine time is devoted to the latter. In order to keep programming costs at a minimum, extensive use is made of the Library of Univac I Routines whenever possible. Time is also made available on an open shop basis and users and area businessmen are encouraged to familiarize themselves with the various mathematical compilers and automatic programming routines by attending one or more of a series of classes periodically conducted at the Center. Business applications such as payroll reporting, cost account reporting, sales statistical summarizations and various statistical analyses have been done for a number of firms. Scientific applications include the engineering problem solutions from areas such as helicopter design, nuclear reactor design, bearing design, geodetic surveys and many others.

The Franklin Life Insurance Company
Located at 800 South Sixth Street, Springfield, Ill., the two systems are operated back-to-back applied to insurance activities.

Great Northern Railway Company
Located at 175 East Fourth, St. Paul, Minnesota, system is used for material, payroll, car records, freight revenue statistics, capital expenditures, sales statistics, and passenger statistics applications.

Photo by Pacific Mutual Life Insurance Company

University of Pennsylvania Computing Center
The Univac I System is being used by the University for a variety of research problems and for commercial applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	12 (11 plus sign)
Decimal digits/instruction	6
Instructions/word	2
Instructions decoded	63
Instructions used	45
Arithmetic system	Fixed point
Instruction type	One address
Number range	Between -1 and +1

Floating point is performed by sub-routines supplied with the computer. The decimal point occurs at the right of the sign digit.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	525	282.6
Mult	2,150	1,907.6
Div	3,950	3,707.6

Construction	5,000 vacuum tubes
Rapid access word registers	4
Basic pulse repetition rate	2.25 Mc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

The minimum storage access time is 40.4 microseconds.
The maximum storage access time 404 microseconds.

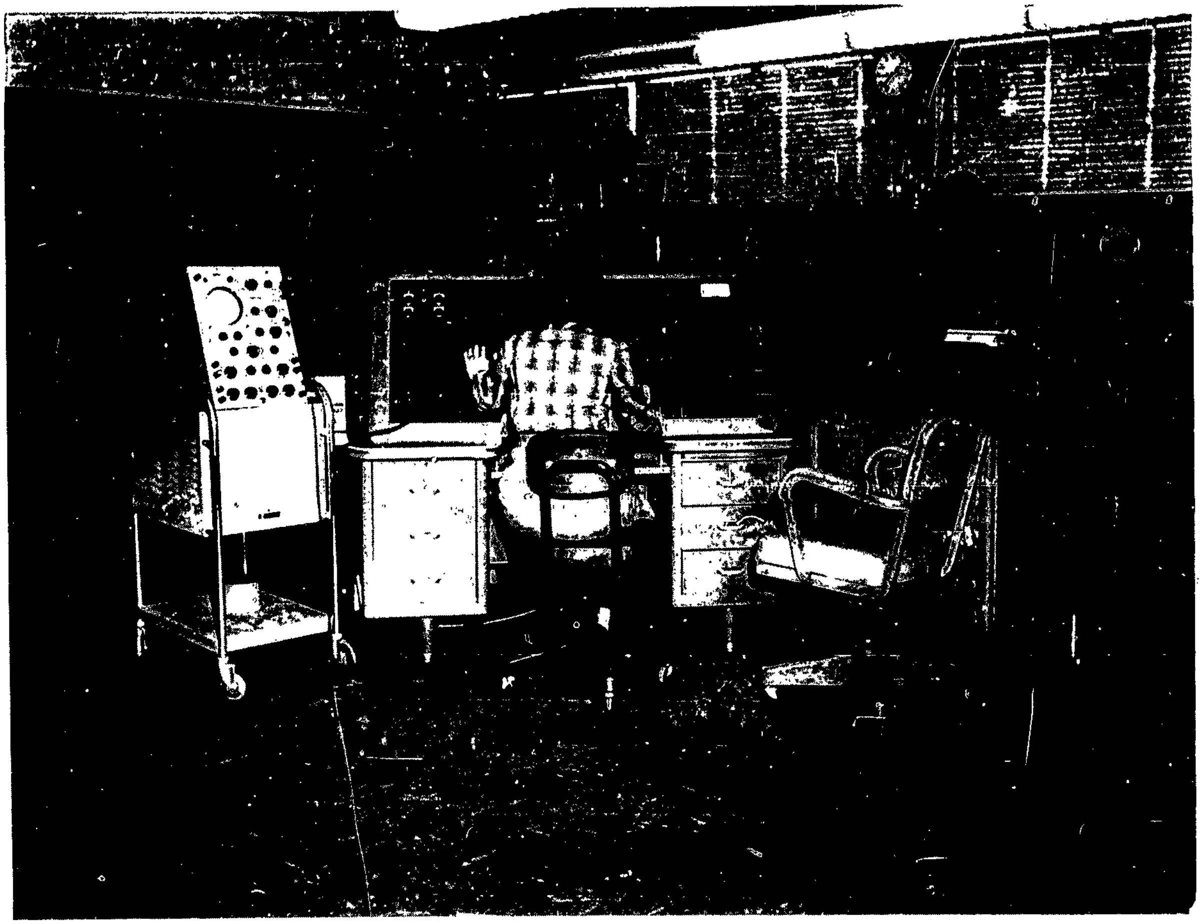
STORAGE

Manufacturer

Medium	No. of Words	No. of Digits	Access Microsec
Acoustic Delay Line	1,000	12,000	40.4 to 404

The acoustic medium is mercury. If average access time is 5 word times, the average access time would be 202 microseconds.

All users have 1,000 words of mecury delay line memory.



- Photo by David Taylor Model Basin

Franklin Life

10 words of information are stored serially in a memory channel which is 400 microseconds long. Access time may be materially reduced from 200 microseconds average if minimum latency programming is employed.

Great Northern

Media	No. of Words	No. of Digits	Access Microsec
Mercury Delay Memory	1,000	12,000	40 min
4 One Word Mercury Delay Registers	4	48	40
1 Two Word Register	2	24	80
1 Ten Word Register	10	120	400

Input-output storage areas give an additional 60 words or 720 digits each of storage.

INPUT

Manufacturer

Media	Speed	
Magnetic Tape (UNISERVO I)	12,800 char/sec	
Keyboard	Manual	
Unityper II	Keypunching	50 char/in density
Verifier	Keypunching	Verifies Unityper II recording

80 Column Card-to-Tape Converter	240 char/min	120 char/in density
90 Column Card-to-Tape Converter	240 char/min	120 char/in density
Paper Tape to Magnetic Tape Converter	200 char/sec	5, 6 or 7 channel code
Magnetic Tape to Magnetic Tape Transrecorder	90 char/sec	Speed dependent upon communication facilities

Army Map Service

Media	Speed
Magnetic Tape (on-line)	12,800 char/sec
Uniservo I - metallic tape only used	
Keyboard (on-line)	Manual typing
Unityper II (off-line)	Manual typing
80 Col. Card-Tape Converter (off-line)	240 cards/min

One 80 col. card converted to 10 word item on tape

David Taylor

Magnetic Tape	100 in/sec	10 Uniservos

Air University

Cards-to-Magnetic Tape Through card to tape converter	100 cards/min
Typing-to-Magnetic Tape Through Unityper	40 words/min

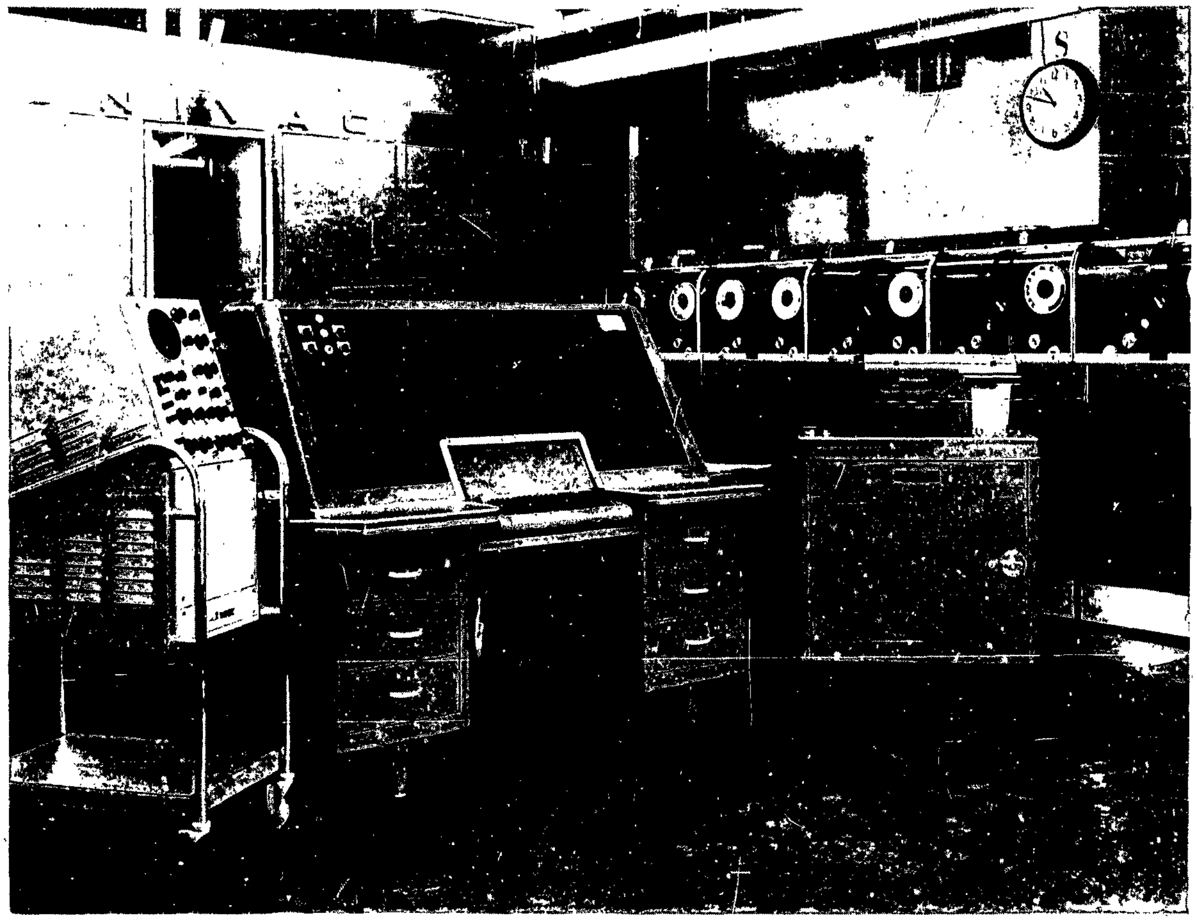


Photo by Wright-Patterson Air Force Base

Media	Speed
C and O	
Metallic Tape	100 in/sec
Franklin Institute	
Magnetic Tape	12,800 char/sec
Plastic Tape	12,800 char/sec

System modified to read 16,000 char/sec on continuous read.

Franklin Life	
Magnetic Tape (metal)	7,200 char/sec
(Both systems)	Assumes tape limited program

OUTPUT

Manufacturer

Media	Speed	
Uniservo I	12,800 char/sec	
Printing Unit	10 char/sec	
Uniprinter	10 char/sec	20 char/in density
High Speed Printer	600 lines/min	130 char/line (max)
Tape-to-Card Converter	120 cards/min	80 column cards
Magnetic Tape to Paper Tape Converter	50 char/sec	5, 6 or 7 channel code
Magnetic Tape to Magnetic Tape Transrecorder	90 char/sec	Speed dependent upon communication facilities

Media	Speed
Army Map Service	
Magnetic Tape (on-line)	12,800 char/sec

Uniservo I - metallic tape only used

Typewriter (on-line)	10 char/sec
High Speed Printer (off-line)	600 lines/min

120 char/line - 51 printable characters

Point Plotter (off-line)	Up to 50 pts/min

40"x40" plot table - magnetic tape input

Some non-standard symbols on High Speed Printer, such as Greek letters, degree symbol.

David Taylor	
Magnetic Tape	100 in/sec
Rem Rand High Speed Printer (off-line)	600 lines/min 120 char/line
Uniprinter (on-line)	10 char/sec
Air University	
Tape-to-Card	100 cards/min
Tape-to-Printer	600 lines/min
C and O	
Metallic Tape	100 in/sec
Franklin Institute	
Magnetic Tape	12,800 char/sec
Plastic Tape	12,800 char/sec

System modified to write 16,000 char/min on continuous write.

Photo by Wright Patterson Air Force Base

Media	Speed
Franklin Life	
Magnetic Tape (metal) (Both systems)	7,200 char/sec Assumes tape limited program

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	5,200
Tube types	15
Crystal diodes	18,000

Army Map Service

The tube types used throughout the entire system include the 25L6, 6AN5, 7AK7, 6AU6, 6BE6, 6SN7, 6X5, 6AK7, 28D7, 807, 829B, 2050, 5545, 5651, 5687, 6AL5, 6AK5, 6AH6, 5V4, 5R4, 4D32, 3C23, 8008. The system includes the computer, power supply, supervisory control, printer and 8 Uniservos.

Franklin Life

Approximately 50% of the tube complement are 25L6's. Each of ten Uniservos (tape handlers) are separate and interchangeable.

CHECKING FEATURES

Manufacturer

Duplicate circuitry for checking results of computation and comparison.

Odd-even pulse

Read-in and read-out pulse check on the 720-digit auxiliary storage.

Three minute interval pulse check.

Automatic re-read provides for reading a block from the tape again when the first reading indicates an error. Marginal checking causes weak tubes to fail during scheduled maintenance instead of during production time.

Army Map Service

Trouble shooting and indicating checks on this system include:

DC fault test and locator
Primary alarm circuits
Audio check
Mercury tank heater monitor
Storage checker
Checking circuits
Marginal check
Function table checker and neon bank
Duplicate arithmetic circuits

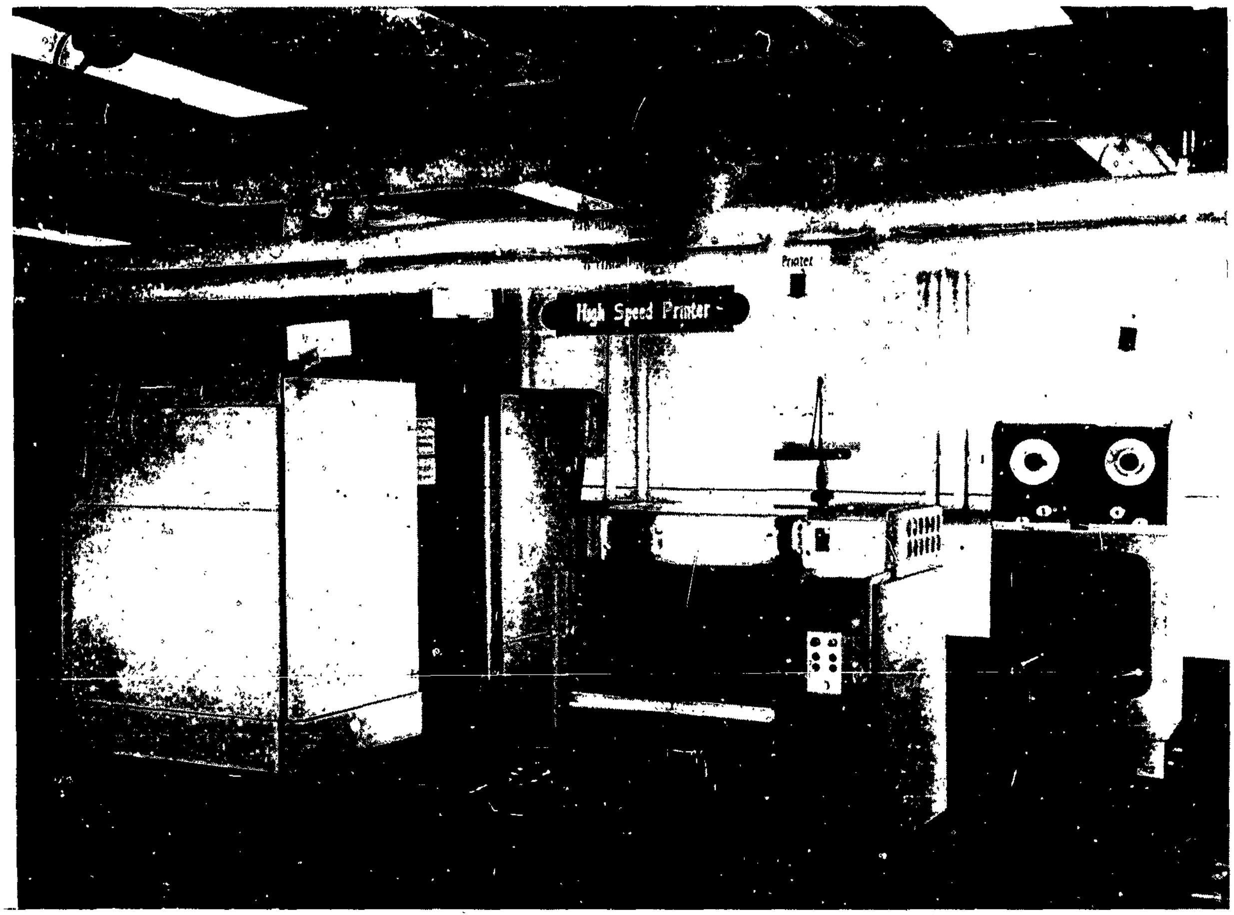


Photo by Wright-Patterson Air Force Base

Test bench and various test equipments
2 modifications for checking purposes
ACC voltage monitor either by meter or scope
Every character has an odd number of pulses. Odd-even checkers on input and output buffers and in other circuits within the machine. Other automatic internal checking features also included.

David Taylor

Checking summarized as parity, comparison and counting.

Franklin Institute & Univ. of California Radiation Laboratory

Parity check throughout system, character count on each block of input and output, and parallel computing.

Franklin Life

No programmed checks are used in normal operation, except during maintenance time, because of the comprehensive hardware checking circuits mentioned above.

Odd-even check of each decimal digit transferred within main computer and of digits coming from or going to magnetic tape.

Duplicated circuits of all arithmetic operations and most control functions.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	81 Kw	90 KVA	0.98 pf
124.5 KVA w/10 Uniservos and power supply			
Volume, computer	943 cu ft		
Area, computer	16 ft x 22 ft		
Height, computer	8 ft 6 9/16 in		
Width, computer	14 ft 3 3/8 in		
Depth, computer	7 ft 10 in		
Weight, computer	16,686 lbs		
Capacity, air conditioner	35 Tons		

The choice of air conditioner is optional with customer. A closed chilled-air system cools the Central Computer Group and heavy auxiliaries. Chilled water must be supplied at a temperature from 45° to 50° with controls to the Power Supply and the Central Computer. The Central Computer and the Power Supply Unit require 35 Tons of refrigeration.

Franklin Institute

Center on first floor of Museum building; air conditioning, power supply, etc. routed from basement to direct overhead. Vinyl tile floor, acoustical ceiling. Adjacent theater, viewing platform and progress of mathematics exhibit included in air conditioning requirements.

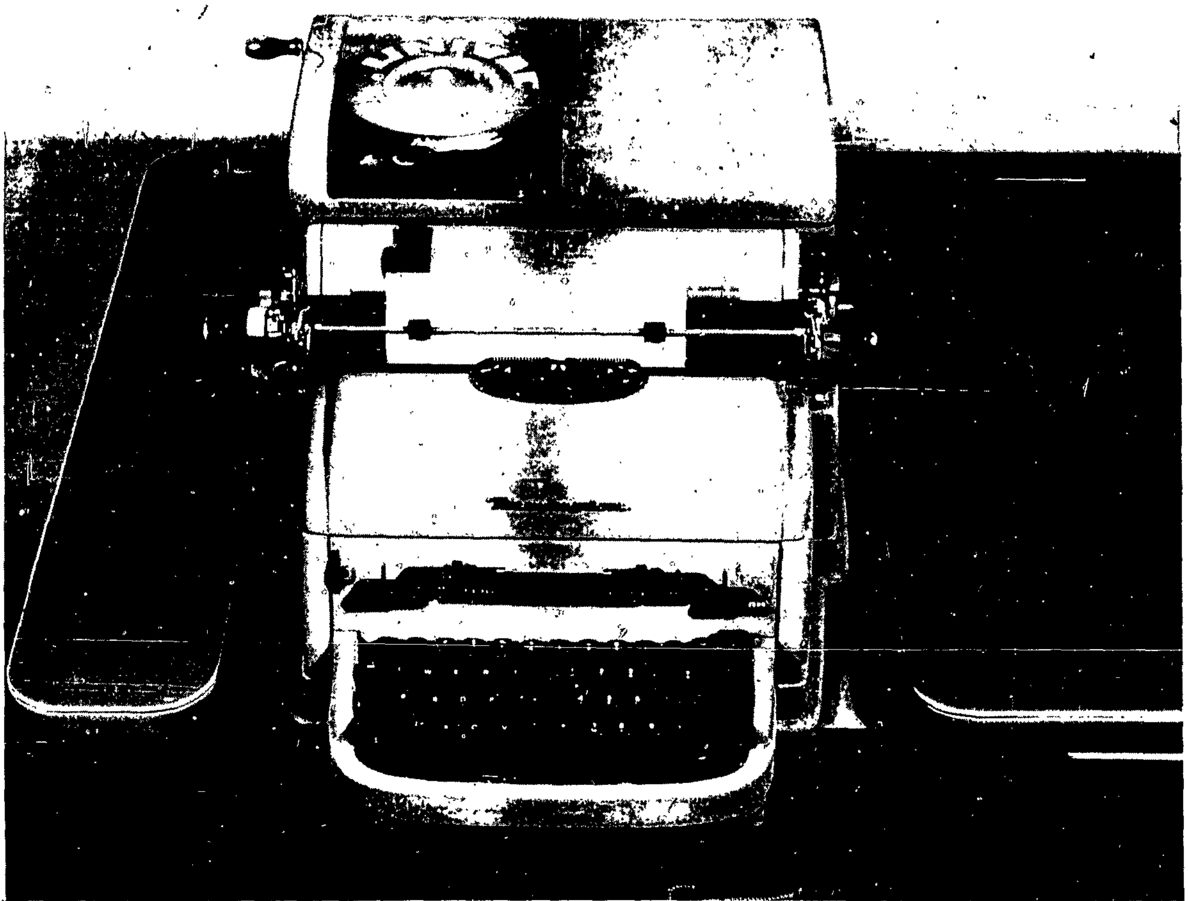


Photo by Wright-Patterson Air Force Base

Army Map Service

Power, computer	125 KVA
Room size, computer	1,400 sq ft

(Not including peripheral equipment or personnel)

Capacity, air conditioner	50 Tons
Weight, computer	19,000 lbs

False ceiling installed - return-air ducts above false ceiling. No false floor - cabling between equipment, and input air ducts, suspended from ceiling of floor below. Control system cooled by air system rather than chilled water - automatic controls to switch between direct outdoor air and internal re-circulating conditioned air depending on outside temperatures. Computer designed for 2-phase power-80 KVA Scott transformer used to convert from 3-phase.

David Taylor

Power, computer	129.5 KVA
Volume, computer	11,000 cu ft
Volume, air conditioner	4,200 cu ft
Area, computer	1,000 sq ft
Area, air conditioner	600 sq ft
Room size, computer	20 ft x 50 ft
Room size, air conditioner	40 ft x 15 ft
Floor loading	100 lbs/sq ft
Capacity, air conditioner	35 Tons
Weight, computer	29,853

Air University

Power, computer	170 KVA
Area, computer	50 ft x 70 ft
Area, air conditioner	12 ft x 30 ft
Capacity, air conditioner	35 Tons
Weight, computer	40,500 lbs

False floor, air conditioning, and power cubicle.

Bureau of the Census

Power, computer	124 Kw 125 KVA 0.9 pf
Volume, computer	10,660 cu ft
Area, computer	1,066 sq ft
Room size, computer	50 ft x 34 ft x 10 ft
Floor loading	167-295 lbs/sq ft
Weight, computer	29,863 lbs each

Air conditioning is part of integrated system. Separate figures not available.

Univac I, Serial 1 - Partitioning area from larger open space. Construction of fire walls and provision of fire doors. Drilling holes in 10 inch concrete floor for air passages; one 2 ft x 7 ft and three 2 ft x 2 ft. Installation of intake grills and exhaust plenum. Construction of fan room on floor below computer. Run of power wiring conduits from basement to third floor.

Univac I, Serial 13 - Area provided for in preparation for Serial 1. Required only the addition of necessary power conduits and chilled water lines from

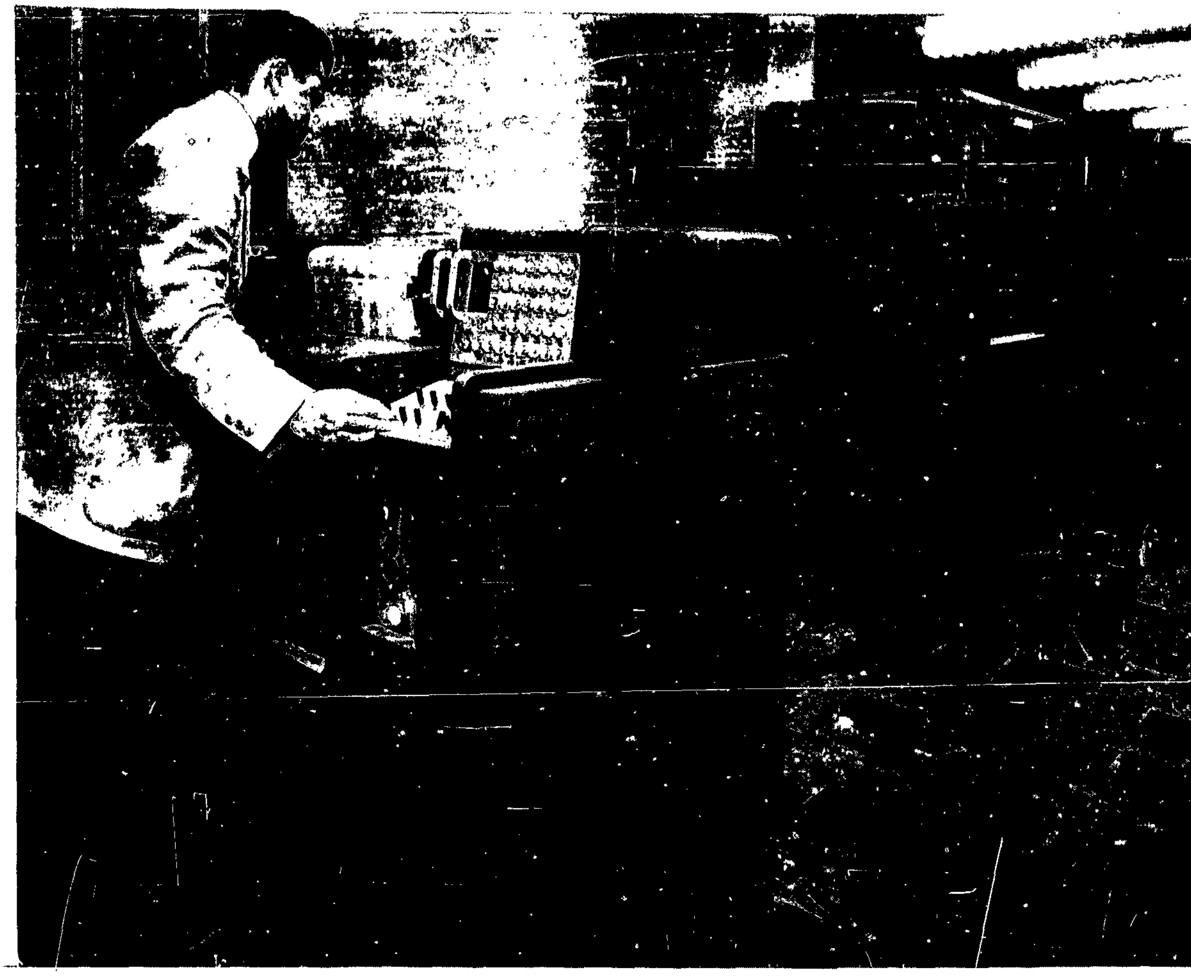


Photo by Franklin Life Insurance Company

basement to third floor.

C and O

Power, computer	150 KVA	0.9 pf
Power, air conditioner	35 Amps at 440V	
Volume, computer	2,322 cu ft	
Volume, air conditioner	600 cu ft	
Area, computer	391 sq ft	
Area, air conditioner	100 sq ft	
Room size, computer	1,200 sq ft	
Room size, air conditioner	170 sq ft	
Floor loading	175 lbs/sq ft	
	250 lbs concen max	
Capacity, air conditioner	50 Tons	
Weight, computer	28,040 lbs	

Building of concrete and steel construction; power fed through 3-inch conduit from power distribution equipment located on floor below computer; lucite false ceiling; room air conditioning through vents in ceiling; cable channels recessed into concrete floor.

Franklin Life

Power, computer	125 Kw	130 KVA	0.96 pf
Power, air conditioner		115 KVA	
Volume, computer		955 cu ft	
Volume, Servo System		150 cu ft	
Area, computer		113 sq ft	
Area, Servo System		30 sq ft	
Floor loading		150 lbs/sq ft	
Capacity, air conditioner		60 Tons	
Weight, computer		16,800 lbs	

Cut 7 holes through adjoining walls of two buildings to allow usage of attic room of one building as switchgear room. Removed part of false ceiling to run power and water lines to the computer. Built cement block room on the roof of adjacent building to house air conditioning equipment.

Franklin Life

Same requirement as above.

Removed 4 feet of wall between two windows to allow sections of the central computer to be craned in. Enclosed 390 sq ft of floor area for switchgear room. Removed part of false ceiling to allow room for computer. Removed portion of false ceiling temporarily to run power from switchgear room to computer and to run chilled water lines. Installed air conditioning equipment in basement.

Great Northern

Power, computer	130 KVA	0.92 pf
Power, air conditioner	40 KVA	0.92 pf
Volume, computer	955 cu ft	
Area, computer	1,650 sq ft	
Room size	1,962 sq ft	
Floor loading	80-125 lbs/sq ft	
	167 lbs concen max	
Weight, computer	16,686 lbs	

Air conditioning system is chilled water for cooling computer, power supply and auxiliary equipment. 3 inch pipe columns installed from ceiling to floor on floor below computer.

PRODUCTION RECORD

Number produced to date	48
Delivery Time	Availability basis

COST, PRICE AND RENTAL RATES

Manufacturer

Description	Base Monthly Rental 1 Shift-5 day week	Outright Sale Price F. O. B. Factory
UNIVAC I Central Computer w/ Power Supply & Supervisory Control Desk	$13,390	$750,000
UNISERVO I	320	18,000
UNIPRINTER	390	22,000
UNITYPER II	90	4,500
High Speed Printer	3,300	185,000
Card-to-Tape Unit (47 Character Code)	2,520	142,100
Card-to-Tape Unit (38 Character Code)	2,500	---
Tape-to-Card Unit	2,300	130,000
Perforated Tape-to-Magnetic Tape (PTM) Converter	1,800	108,000
Magnetic Tape-to-Perforated Tape (MTP) Converter	1,500	90,000

Prices quoted above subject to change without notice. Rental charges include maintenance service, spare parts and test equipment. Separate maintenance contract and maintenance advisory service contract available to purchasers of UNIVAC Systems.

Army Map Service

Basic System

Central computer, 8 Uniservos, high speed printer, and 3 Unityper II's cost approx. $600,000 (1952 price) (also 2 Unityper I's, 4 Uniprinters - no longer used).

Rental Rates for Additional Equipment

80 Col. Card-Tape Converter $2,520/month. IBM Card Equipment - six 024 Keypunches, one 083 Sorter, one 089 Collator, one 407 Tabulator, one 514 Reproducer, and one 557 Interpreter rents for $1,900/month.

Maintenance service is approx. $9,700/month for seventeen 8-hour operational shifts per week.

David Taylor

Cost of Basic System

Central Processing Unit, 10 Uniservos, Uniprinter, and 2 Unityper I were purchased at a total cost of $1,000,000.

Cost for Additional Equipment

Card to Tape Converter 185,000

Rental Rates for Additional Equipment

1 Unityper II 90/month

Rem Rand High Speed Printer 3,300/month

Service contract with Rem Rand, approx. $8,000/mo.

Air University

Cost of Basic System

UNIVAC Main Computer and 11 Servos - $500,000 (purchased in 1952).

Cost of Additional Equipment

Card to Tape Converter, High Speed Printer, Unityper-Verifier, and 3 Unitypers - $353,000.

Rental Rates for Additional Equipment

Tape to Card Converter 2,385/month

Maintenance cost $75,000 per year (3 shifts).

Bureau of the Census

Basic System

2 Univac I, 10 tape units each, non-expendable parts, test equipment, site preparation and installation, initial parts inventory $1,857,000 total

Additional Equipment

No longer in use: 2 low speed printers, 1 card-to-tape converter, 1 Unityper, Mod. 1.

Remaining in use: 1 high speed printer, 1 Unityper, 1 extra print head, 1 printer buffer $271,000.

3-shift maintenance contracts for each of 2 Univac I Computers at standard Remington Rand rates.

C and O

Terminal Tower, Cleveland

Own Central Computer & Servos	- cost	$873,000
Own 1 High Speed Printer	- cost	130,000
Lease 1 High Speed Printer	-	4,700/month
Lease 1 Card-to-Tape Converter	-	2,605/month
Lease 1 Tape-to-Card Converter	-	2,300/month
Lease 1 Unityper	-	90/month

Maintenance contract on computer and servos - $8,000/month.

Maintenance contract on 1 high speed printer - $500/month.

Case Institute of Technology, Cleveland

Central Computer and Servos (2 - 8 hour shifts) $26,950/month.

Frankling Life

Basic System

1 Univac I Computer (10 Servos), 2 high speed printers, and 20 Unitypers (exclud. installation) cost $1,200,000.

All maintenance is performed by Frankling Life personnel.

Franklin Life

1 Univac I System (10 Servos) excluding installation cost $300,000.

All maintenance is performed by Franklin Life personnel.

Great Northern

Univac Computer, 10 Servos, and console cost $1,000,000.

High speed printer - 600 lines per minute, card-to-tape converter cost $500,000.

Service contract - Computer 2 shifts $5,310; printer 2 shifts $1,522.50; Card to tape 1 shift $740.

PERSONNEL REQUIREMENTS

Manufacturer

The number of engineers, technicians, and operators required depends upon the equipment complement of the Univac System and the shift operation.

Army Map Service

	Three 8-Hour Shifts
Supervisors	8
Analysts	8
Programmers	15
Clerks	3
Operators	6
Engineers	1
In-Output Oper	11

Operation tends toward closed shop.

Methods of training used include basic training by equipment manufacturers (e.g. Rem Rand programming, IBM card equip operation), on-the-job training by experienced personnel and supervisors, advanced training - university courses in mathematics, etc., and Personnel Division training facilities for supervisory training.

Central Computer operating 3 shifts 6 days/week.

Peripheral (in-output) equip operating 1 shift 6/days.

Programming - 1 shift 5 days.

Present Organization Structure
Present Authorized Strength - 52

Programming Br.-18 Applications Chief, Asst Chief, Research Br. Clerk-Typist 1 15 Programmers

Computing Br - 29 Chf, Asst Chf, Adm Clerk-Tape Librarian

Operations Unit 1 Supervisor

7 Project Mathematicians

6 Systems Operators

In-Out Oper 1 Asst Supvr

6 Input Equip Oper

5 Output Equip Oper

David Taylor

	One 8-Hour Shift	
	Used	Recommended
Analysts	8	8
Progr mers	12	12
Coder	0	0
Clerks	0	0
Librarians	0	1
In-Output Oper	1	3

Operation tends toward closed shop.
Methods of training used include on-the-job and by the manufacturer.

Air University

	Three 8-Hour Shifts
Supervisors	1
Programmers	4
Clerks	1
Operators	7
Technicians	5

Operation tends toward closed shop.
Methods of training used includes on-the-job training. Programmers attended manufacturer's programming school.

Bureau of the Census

	Three 8-Hour Shifts
Supervisors	3
Analysts, programmers & coders	20
Clerks	5
Librarians	2
Operators	9
Engineers	1
Technicians	10
In-Output Oper	6
Tape Handlers	10
Other	1

Programmers shown are customer employees; technicians are contract maintenance employees; tape handlers are customer employees.
Operation tends toward open shop.
Training Branch conducts formal classroom sessions for programmers, operators (followed by on-the-job training) executive orientation, brush-up seminars. Classroom and on-the-job training are also conducted for engineers and technicians.

Internal Revenue

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	--
Analysts	4	6
Programmers	15	20
Clerks	3	4
Librarians	2	2
In-Output Oper	3	3
Tape Handlers	1	2 to 4

Programming courses provided by manufacturer when available.
Programming course presented by an experienced Division programmer.
Programming course presented by other owners such as Bureau of the Census.

C and O

	Five 8-Hour Shifts
Supervisors	7
Analysts	6
Programmers	11
Clerks	8
Operators	8
Engineers	7
Technicians	4
In-Output Oper	6

Personnel are for two systems.
Operation tends toward closed shop.
Computer operators trained by manufacturer, auxiliary equipment operators trained on-the-job.

Franklin Institute

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	U	Rec	U	Rec	U	Rec
Clerks	1	1	1	2	1	2
Librarians	0	1	0	1	0	1
Operators	2	2	4	4	5	6
Engineers	1	1	1	1	1	1
Technicians	3	3	5	5	6	6
Tape Hand	0	0	0	0	0	0

Operation tends toward closed shop.
Methods of training used includes: programmers - formal classes plus study; maintenance and operations-informal classes, study and on-job training.

Franklin Life

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	1	1
Analysts	1		
Programmers	8		
Coders	6		
Clerks	50		
Librarians	1		
Operators	2	2	2
Engineers	2	1	1
Technicians	2	2	2
In-Output Oper	20	10 (4 hrs)	

The same staff of employees is used to maintain programs and operate both computers.
Operation tends toward open shop.
Methods of training includes on-the-job training with an experienced employee.

Great Northern

	Two 8-Hour Shifts	
	Used	Recommended
Programmers	1	
Operators	2	
Engineers	4	5
Technicians	1	2
In-Output Oper	3	
Tape Handlers	1	

Operators and tape handler schooled by equipment manufacturer. The machine is serviced by the manufacturer.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Reliability and operating experience are based on several years records. Using the formula "Available Operating Time" minus "Lost Time" divided by "Scheduled Operating Time", cumulative performance of the UNIVAC I Central Computers averages 93.0%.

Army Map Service

Good time	125 Hours/Week (Average)
Attempted to run time	136 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.92
Above figures based on period from 1957 to present
Passed Customer Acceptance Test Apr 52
Time is not available for rent to outside organizations.

Small increments of time occasionally made available for other Dept. of Defense offices (usually Corps of Engrs agencies), only when specifically so directed by higher authority (Office of Chief of Engrs, U. S. Army).

David Taylor

Good time	114 Hours/Week (Average)
Attempted to run time	120 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.95-0.97
Above figures based on period 1 Jul 59 to 31 May 60
Passed Customer Acceptance Test Apr 53
Time is available for rent to qualified outside organizations.

Air University

Good time	80 Hours/Week (Average)
Attempted to run time	100 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.80
Above figures based on period from Jan 60 to Jul 60
Time is available for rent to qualified outside organizations.

System was first installed in Pentagon in 1952. It was moved to Maxwell AFB in 1958.

Bureau of the Census

Good time (each machine)	137 Hours/Week (Average)
Attempted to run time	148 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.926
Above figures based on period 3 Apr 60 to 23 Apr 60
Passed Cusotmer Acceptance Test: Serial 1 (51);13 (55)
Time is not available for rent to outside organizations.

Good time includes lost time from non-machine causes. Attempted to run time excludes scheduled maintenance. Figures are for each machine.

C and O

Average error-free running period	24 Hours
Good time	186 Hours/Week (Average)
Attempted to run time	192 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period from Mar 57 to Jun 60
Passed Customer Acceptance Test Feb 56
Time is available for rent to qualified outside organizations.

E. I. du Pont de Nemours and Company

Average error-free running period	168.6 Minutes
Good time	3,707 Hours

(Scheduled minus Down Time minus All Lost Time)

Attempted to run time	3,895 Hours

Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period 23 Dec 55 to 20 Dec 56.
Passed Customer Acceptance Test 10 Apr 55

Franklin Institute

Good time	57 Hours/Week (Average)
Attempted to run time	60 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.95 to 1.0
Above figures based on period from Jan 57 to Jan 60
Passed Customer Acceptance Test Jan 57
Time is available for rent to outside organizations.

The machine is available on an hourly rental basis and only good time is charageable; no minimum time requirement exists.

Hourly Rates for Use of Computer and Peripheral Equipment

Computer (UNIVAC I)

Hours/Fiscal Month	Dollars/Hour
less than 22	120
22 and between 22 and 44	115
44 and between 44 and 88	110
88 and between 88 and 176	105
176 and up	100
Unityper or Keypunch	3
High Speed Printer	15
Card-to-Tape Converter	10
Uniprinter	5

The above rates include good machine time and an operator and use of a large library of routines. Reasonable quantities of accompanying deleaving and bursting of multiple-part forms are performed without charge.

Customer is billed for time used to the nearest minute. No minimum charge.

Discount

A ten (10) percent discount will be allowed on Univac I Computer billing for those contracting for 22 or more hours in any fiscal month, subject to the following provision. A contract, purchase order, or the equivalent must be in effect prior to the beginning of the month of machine use for a specified amount of time that will be paid for by the customer whether used or not. The discount will be allowed on the specified amount of Univac I Computer time only, regardless of the acutal amount of time used. Time used in excess of that contracted for in this way will not be subject to the discount. The discount does not apply for peripheral equipment usage.

Services of Additional Personnel

The services of additional personnel are available for analysis, programming, coding and instruction or training of others on scientific or industrial applications at the following direct labor hourly rates which are subject to our standard overhead rate:

Senior Methods Analyst	$5
Methods Analyst	4
Programmer	3

Supplies

The hourly rates listed above include the normal use of magnetic tape and continuous forms. Tabulating cards, special forms and other supplies are not included and all such materials, including tapes to be retained by the customer, will be billed at prices currently in effect and will represent an additional charge.

Estimates

Estimates or proposals are furnished upon request at no cost or obligation. Proposals can be based on a cost plus overhead, time and services, or fixed-price basis.

Agreements

We will start on receipt of your contract, purchase order, or written go-ahead. Operation is on a 4, 4, 5 week quarter. Fiscal January 1960 ends January 29. Billing is monthly unless specified otherwise.

Inquiries

Inquiries should be addressed as above or call LOcust 4-3600, Ext. 246 (Philadelphia 3, Pa.).

Effective Date

This rate schedule is effective 1 January 1960, and is subject to change.

Franklin Life
Good time 127 Hours/Week (Average)
Attempted to run time 148 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.867
Above figures based on period 1 Jan 60 to 1 Apr 60
Time is available for rent to outside organizations.

Franklin Life
Good time 138 Hours/Week (Average)
Attempted to run time 148 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period 1 Jan 59 to 31 Dec 59
Passed Customer Acceptance Test 15 Mar 55
Time is available for rent to outside organizations.

General Electric Company
Good time 82.9 Hours/Week (Average)
Attempted to run time 93.9 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.872
Above figures based on period 2 Sep 56 to 23 Dec 56.

The "Good" time/week indicated above does not include re-run time. Good time is defined as the time that the Univac was producing good, usable output that did not have to be redone for any of a number of reasons associated with tape or machine malfunctions.

Great Northern
Good time 76 Hours/Week (Average)
Attempted to run time 80 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Oct 58 to present
Passed Customer Acceptance Test Mar 56
Time is not available for rent to outside organizations.

System is operated 2 shifts per week.

New York University, AEC Facility
Good time 3,740 Hours
Attempted to run time 4,084 Hours
Operating ratio (Good/Attempted to run time) 0.91
Above figures based on period from Jan 56 to Jul 56
Passed Customer Acceptance Test Nov 52

These figures were essentially constant for two and one-half years.

Pacific Mutual Life Insurance Company
Operating ratio (Good/Attempted to run) Exceeds 0.90
Above figure based on period from Oct 55 to Dec 56

University of California Radiation Laboratory
Average error-free running period 5.5 Hours
Good time 1,816 Hours
Attempted to run time 2,000 Hours
Operating ratio (Good/Attempted to run time) 0.91
Above figures based on period 1 Jul 56 to 30 Sep 56
Passed Customer Acceptance Test 19 Nov 52

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Library and compiler routines for mathematical and commercial use and service routines for maintenance use are available to customers.

In addition to the checking circuits in the Central Computer, the Card-to-Tape Converter, the Tape-to-Card Converter and the High Speed Printer contain built-in checking features.

Design features which facilitate maintenance include accessibility of chassis through doors in the casework and accessibility of interwiring between chassis from inside.

Simultaneous reading, writing and computation are possible due to built-in buffer units.

Univac can read from one Uniservo; write on a second and rewind a third. Unless there is another read, write or rewind instruction immediately following, Univac may continue to compute while the reading, writing, and rewinding operations are being performed.

Army Map Service

Only metallic tape is used - on site storage in metal cabinets (standard supply cabinets w/vertical dividers on each shelf) and tape carts. Duplicates of program tapes in fireproof cabinets and duplicates of important permanent file data at Army Map Service Depository.

Machine was operated by Army Map Service at factory (Philadelphia) from date of acceptance, April 1952, until September 1952. After Serial No. 2 machine was installed and checked out in Washington (Air Force-Pentagon), and Serial No. 4 was completed and operating at factory, this machine was moved to its present site at Army Map Service. Full operation by Army Map Service started 4 January 1953, and machine has been operating 3 shifts/day 6 or 7 days/week ever since.

Bureau of the Census

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage, includes fire wall construction; metallic containers for magnetic tape, fire fighting organization and training, control system for defective and damaged tapes, standardization of tape reel lengths and markings.

C and O

Outstanding features include accuracy, reliability and duplicated circuitry.

Tape labelling by Labelon Marking Tape; permanent wall cabinets provided for tape storage to protect against dirt and physical damage.

Leased time from Case Institute includes only the Central Computer and not the auxiliary equipment.

Franklin Institute

System is maintained by Franklin Institute personnel. Changes and modifications provide 15% to 25% increase in speed without affecting Univac I compatability.

Labelon and self sticking adhesive used to identify tapes. Metal wall cabinets provide storage for 3,600 tapes. Area completely air conditioned and humidity and temperature has never been problem. Area in use or patrolled at all times and equipment available to minimize fire hazard.

Open or closed shop operation on 3 shift basis. Government, industrial and scientific work.

Univac System Changes

Continuous Write

A continuous write feature has been installed in the F.I.C.C. Univac I. Start-stop time is eliminated when writing sequential "strings" of data. System evaluation is not possible as the change has been in use only a short time. A complete tape may be generated in a continuous mode, in approximately three minutes (rewind time). A maximum gain of 25% may be expected in tape limited applications.

A continuous read modification is presently being installed.

The continuous write consists of 14 tubes and associated hardware. Installation time is not known since the modification was undertaken on a development basis.

Clear 0 Tanks on Read-In Switch

A switch has been added to select read-in or read-out clear. It has prevented re-runs on many occasions by allowing re-write on output errors.

File Computer Operation

The Remington Rand File Computer is capable of producing tape output that is acceptable to the Univac I Computer. Standard Univac I output cannot, however, be read by file equipment.

F.I.C.C. recently tackled the problem of reverse compatibility. Certain problems center about the difference between the two computers. Other headaches are primarily a result of the use of plastic tapes.

A practical working solution has been found to the Univac I File problem. The necessary modifications have been installed at F.I.C.C. The Univac I can be switched to file mode in approximately one minute.

A list of the changes necessary to generate file output is available upon request.

Empty 1 Tank Inhibit

Circuitry has been installed in the central computer to prevent dumping an empty 1 tank. The circuits actually combine the 1 overlay and empty 1 tank into one modification.

The change involves 2 tubes and associated components. The rewind overload neon on supervisory control was removed and a blinking neon substituted as an indicator.

Q and T Order Modification

It has been demonstrated that a faulty contact can cause loss of screen voltage on one or more tubes resulting in introduction of errors which might remain undected until output is examined and inconsistencies noted.

Through the installation of duplicate backboard terminals, this has been corrected. Univac II installations desiring more technical information on this change are encouraged to request same.

High Speed Printer

The rectifier bottles in the H.S.P. power supply have been eliminated in part. Silicone (Texas Instruments) diodes have been installed. The initial cost of the silicones is less than the price of the "bottles" and a much longer and trouble free life can be expected. Generated heat in the unit has been reduced by two kilowatts.

The silicone diodes have been operational for eight months and have been completely trouble free.

Intermittent operation of the switches on the printer console has been traced to dirt filtering into the switch contacts. A vinyl bag was constructed and the entire area sealed. There have been few troubles since this addition.

Card to Tape

The card to tape card feed unit has been souped up to 320 cards per minute. No circuit changes were found necessary. The unit was retimed for this speed and has performed admirably.

Tektronix Scope

An "A plus B" sweep has been wired into one 535 scope. It allows two signals to be displayed simultaneously on a single sweep. It is particularly useful in observation of signal timing in "difficult to live with" input-output areas.

This change, consisting of one capacitor and one resistor, is being checked out with the Tektronix organization.

Literature

Literature is available on request to Franklin Institute Director, Computer Center, 20th and Parkway, Philadelphia 3, Pa.

Franklin Life

Outstanding feature is dual circuitry.

Great Northern

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include external and internal label, distribution of copies of different tapes in other offices in same building. Plan to purchase fireproof case.

FUTURE PLANS

Army Map Service

Minneapolis-Honeywell H800 Computer currently on order to replace present Univac I. Delivery scheduled for early 1961. Univac I will be retained for at least 6 months to 1 year after H800 delivery, so that conversion process to new equipment can be made in an orderly and gradual manner.

H800 equipment to include the following major features:

16,000 word memory
Floating point operation
2 tape control units
12 magnetic tape units
High speed printer (on or off line)
Card Reader

New applications include:

Processing digitalized map (topographic) data including digital mal library
Preparing tape for controlling router to carve terrain models
Intercontinental geodetric datum adjustments
Special satellite and space programs
Other classified projects

Internal Revenue

An IBM system has been designated for Service wide use. Details of the system as to components, application, etc. are not available for public release at this time. Initial installation of equipment is scheduled for October 1961.

It is planned to compile as much statistics of income data as possible as a by-product of data recording for operational purposes in the described ADP Master File system.

INSTALLATIONS

Bureau of Census
Department of Commerce
Washington 25, D. C.

Office of the Air Controller
Headquarters U. S. Air Force
Washington 25, D. C.

Army Map Service
6500 Brooks Lane
Washington 25, D. C.

Bureau of Ships
Department of the Navy
Washington 25, D. C.

David Taylor Model Basin
Applied Mathematics Laboratory
Washington 7, D. C.

Air University
Maxwell Air Force Base, Alabama

Wright Patterson Air Force Base (AMC)
Air Materiel Command, Dayton, Ohio

Bureau of the Census
Washington 25, D. C.

Bureau of the Census
Federal Office Building No. 3
Suitland, Maryland

Air Materiel Command, Sacramento, California

Air Materiel Command, Gentilly

Internal Revenue Service
12th and Constitution Ave., N. W.
Washington 25, D. C.

New York University (AEC)
45 Fourth Avenue
New York, New York

University of California (AEC)
Radiation Laboratory, P. O. Box 808
Livermore, California

Electronic Computing Center
Remington Rand
315 Fourth Avenue
New York, New York

General Electric Company
310 West Liberty Street
Louisville, Kentucky

Metropolitan Life Insurance Company
One Madison Avenue
New York 10, New York

United States Steel
National Tube Division
525 William Penn Place
Pittsburgh, Pennsylvania

E. I. du Pont de Nemours and Company
Louviers Building
Wilmington, Delaware

United States Steel
Gary Steel Works
Chicago, Illinois

Franklin Life Insurance Company
800 South Sixth Street
Springfield, Illinois

E. R. A.
1900 W. Minnehaha Avenue
St. Paul 4, Minnesota

Pacific Mutual Life Insurance Company
Box 6050, Metropolitan Station
Los Angeles 55, California

Westinghouse Electric Company
P. O. Box 2278 3 Gateway
Pittsburgh 30, Pennsylvania

Electronic Computing Center
Remington Rand
2601 Wilshire Blvd.
Los Angeles, California

Chesapeake and Ohio Railroad
400 Terminal Tower Building
Cleveland 1, Ohio

John Hancock Mutual Life Insurance Company
200 Berkeley Street
Boston, Massachusetts

Consolidated Edison Company of New York

Metropolitan Life Insurance Company
One Madison Avenue
New York 10, New York

Life and Casualty Insurance Company of Tennessee

Frankfurt, Germany, Service Bureau

Sylvania Electric Products, Incorporated
Camillus, New York

Great Northern Railroad
175 E. Fourth Street
St. Paul 1, Minnesota

The Franklin Institute
20th and Parkway
Philadelphia 3, Pennsylvania

University of Pennsylvania
The Computer Center
Philadelphia 4, Pennsylvania

Boston, Massachusetts, Service Bureau

Consolidated Edison
4 Irving Place
New York 3, New York

The Carborundum Company
Buffalo, New York

Sperry Gyroscope

Harvard University
Cambridge, Massachusetts

UNIVAC II

Universal Automatic Computer Model II

MANUFACTURER

Remington Rand Univac Division
Sperry Rand Corporation

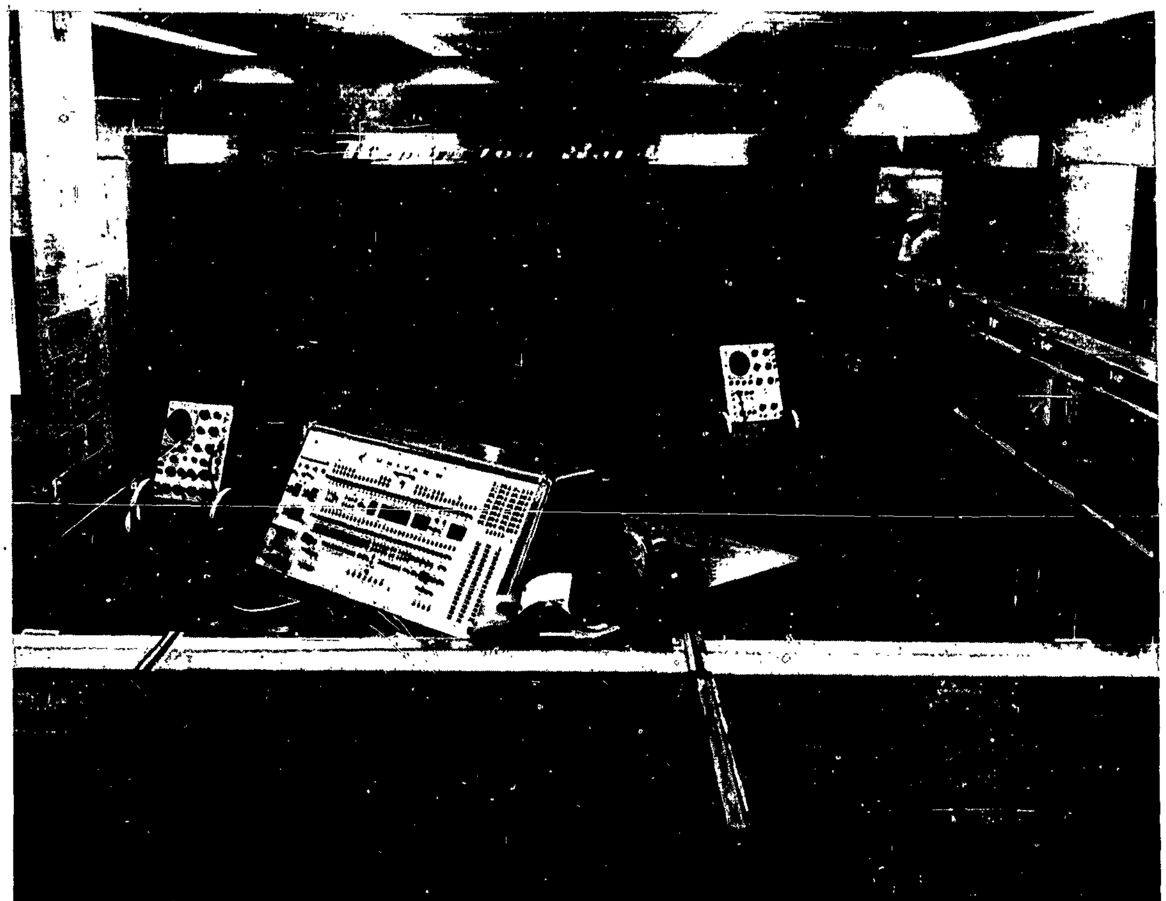


Photo by U. S. Navy Electronics Supply Office

APPLICATIONS

Manufacturer
General purpose digital computer.

U. S. Navy Electronics Supply Office
Located at the Southwest corner of 1st deck, ESO Building, Great Lakes, Illinois, the system is used for inventory control (180,000 items, 21 stock points $200 million value. Weekly stock review, redistribution, procurement, and allocation), for electronic repair parts allowance lists (active plus reserve ships, shore installations, etc. Weekly process), for stock number identification (Technical document for use by electronic technicians), for Tables and Allowance Guides (To maintain and support a specific model of electronic equipment or system. Tri-weekly process), for consolidated load lists (Computed and tailored requirements lists for maintaining proper range and depth of stock aboard tenders and supply support ships. Semi-annual process), for stratification of assets and requirements (A stratified item-by-item comparison of system inventory vs future needs to identify material which will be purchased or declared excess during the apportionment and budget fiscal years. Annual processing), for contractor performance and analysis (Control of material ordered from suppliers to determine; contractor performance, cost, procurement lead time and its variation, overdue contracts, contractor follow-up, etc. Weekly process) and for management statistics (Various statistical controls to measure activity and system effectiveness, stock turn-over, volume of issues, sales, etc. Weekly and quarterly process).

U. S. Department of Agriculture
Commodity Stabilization Service
Located at the CSS Commodity Office, Kansas City, Missouri, the system is used in the Grain Price Support Program. This involves processing price support loan and purchase agreement transactions for the 31 states served by this office as a data processing center for this program. This application includes computation of loan and purchase transactions, prep-

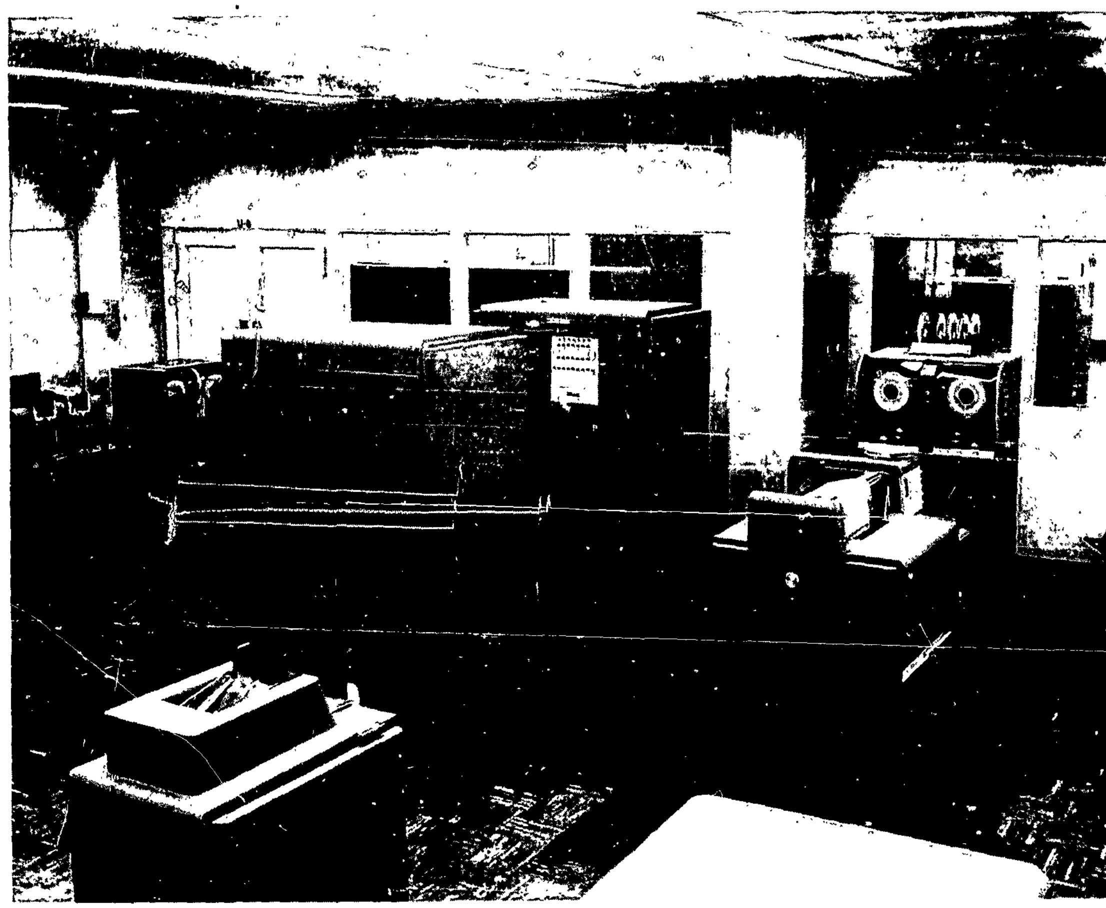


Photo by U. S. Navy Electronics Supply Office

aration of settlement statements with farmers and producers, and recordation of accountability for these transactions - approximately 1 million transactions are processed annually.

Metropolitan Life Insurance Company
Located at 1 Madison Avenue, NYC (3 Univac II's) and 315 Park Avenue So., NYC (across the street - 1 Univac II), the four systems are used for actuarial (classification, valuation, mortality studies and special studies), for debit accounting (preparation of life and lapse registers), for payroll, for city mortgage accounting, and for ordinary policy service (billing, dividend calculation, premium, dividend and commission accounting).

Pacific Mutual Life Insurance Company
Located in the Home Office Building in Los Angeles, California, the computer is used as the integral part of an integrated data processing system used to do our normal billing, collections, valuation, lapses, agents records, commissions, loans, claims and just about every other facet of the ordinary life insurance work. In addition we do some actuarial studies, agency department contest records and several miscellaneous jobs.

United States Steel Corporation
Located at 1509 Muriel Street, Pittsburgh 3, the system is used for accounting, statistical, analytical, and engineering (multiple correlations and regression analyses) problems.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	12
Decimal digits/instruction	6
Instructions per word	2
Instructions decoded	54
Instructions used	54
Arithmetic system	Fixed point
Instruction type	One address
Number range	Between -1 and +1

Decimal point occurs at the right of the sign digit.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	160	120
Mult	1,720	1,680
Div	3,030	2,990

Construction	Vacuum tubes
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

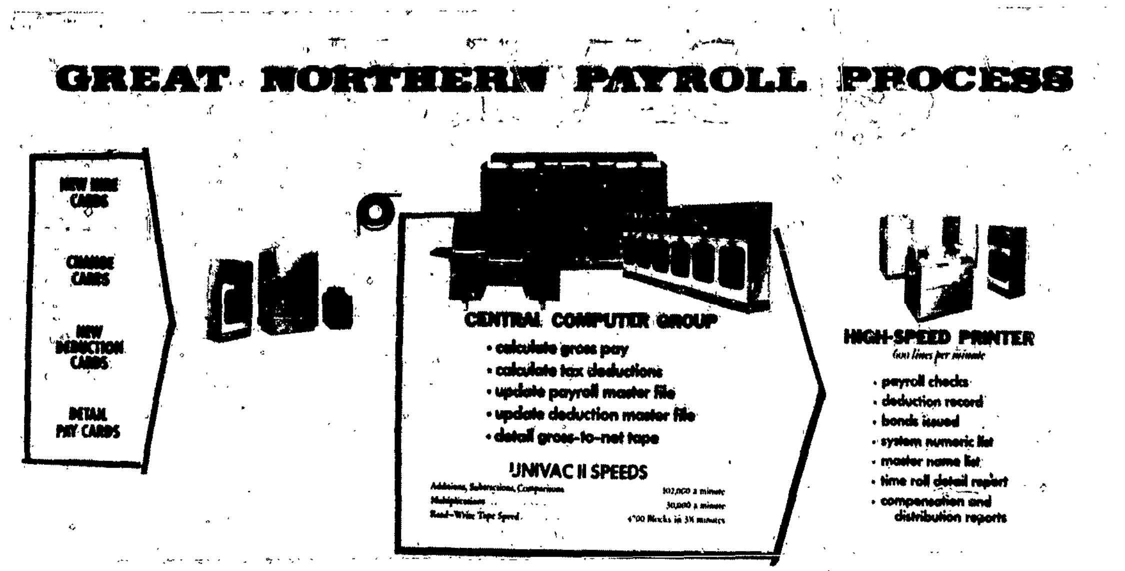


Photo by Great Northern Railway Company

Addition, subtraction, and multiplication times given below include reading and executing the instruction. The time includes formation of the result in the accumulator. All instructions, however are performed at minimum latency rates.

Average Operating Speeds in Microseconds

Addition or Subtraction	200 (11-digit numbers)
Multiplication	1,900 (11-digit numbers)
Division	3,700 (11-digit numbers)
Comparison	200 (12-digit numbers)
Transfer (Memory to Register or vice versa)	40/word + 80/instruction

STORAGE

Manufacturer

Medium	Magnetic Core
Capacity	10,000 words 120,000 characters
Memory Locations	0000 - 1999
Access time	Zero (Memory references begin during "Time Out")
Basic Cycle	20 microseconds
Construction	42 separate magnetic core planes, each one a rectangle 50 cores wide and 80 cores long.

Each of the planes is divided into two sections of 50 by 40 cores, making 2,000 cores in each section. Each section contains one core - for one binary position (bit) - of every one of the 2,000 words. The same relative binary position of the other half-word is held in a core in the same physical location in the other section of the plane. Thus each plane contains two binary positions in each of 2,000 words; the first and 43rd, for example, or the 9th and 52nd. Physically the memory is a rectangular prism 7 1/4 inches x 10 inches x 12 3/4 inches.

A memory location thus always implies two cores in all 42 planes. The two cores are determined by the intersection of one column of fifty possible columns with two rows of the 80 possible rows. One row is in each section of the plane. All 42 planes are used twice for each word.

Associated with the memory is a half-word insertion register of 42-bit capacity. Each bit is temporarily stored in a magnetic core of this register during a memory reference. Each of these register cores is associated with one of the 42 memory planes. To write into the memory, the first half of the word is placed in the insertion register and the address selector alerts the appropriate column and the proper row of the top section in each of the 42 planes. At the appropriate instant the information is transferred from each core of the insertion register to the selected core in the corresponding plane of the memory. 42 pulse times later, the second half word has been placed in the insertion register and the process is repeated in the lower section of the memory. Read-outs are accomplished in a reverse manner. The speed of the memory has been adjusted to the speed of the arithmetic portion of the Univac which permits the transfer into or out of the memory of 12 characters in 40 microseconds. Word pulses flow from or to the high speed bus and the insertion register via a mechanism which converts from serial to parallel and vice versa, in 42 bit modules.

All users utilize a 2,000 word 24,000 digit, magnetic core storage unit.

Commodity Stabilization Service

16 - Uniservo II's

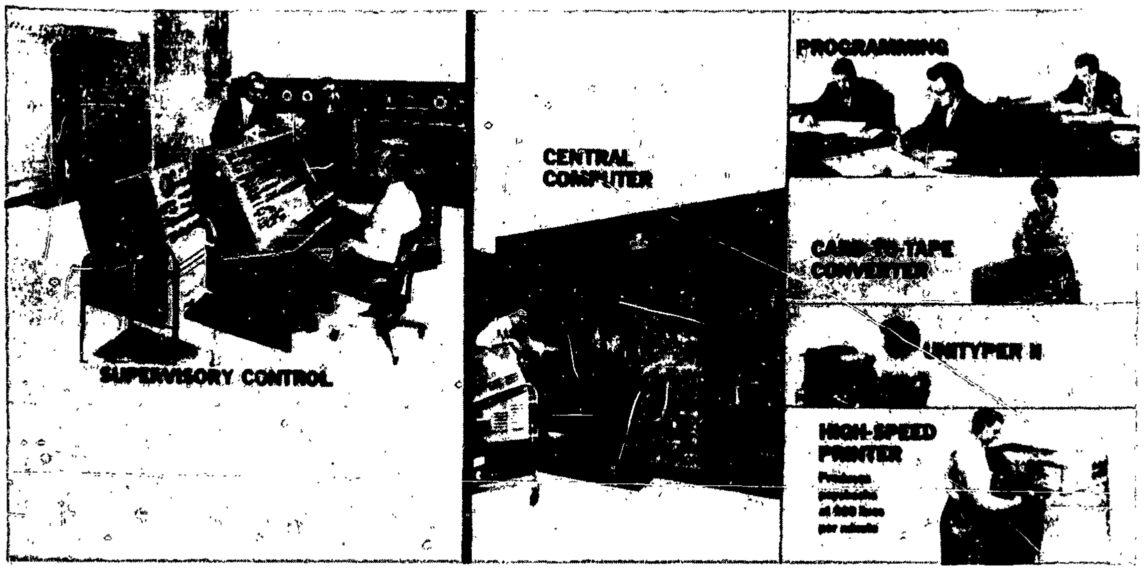


Photo by Great Northern Railway Company

INPUT

Manufacturer

Media

Magnetic Tape (Uniservo II)	20,12.4, or 5 Kc digit rate; 100 in/sec
Keyboard	Manual
Unityper II	Manual (50 char/in density)
Card to Tape Converter	240 cards/min (80 or 90 col cards)
Paper Tape to Magnetic Tape Converter	200 char/sec (5, 6 or 7 channel)
Verifier	Keypunching (Verification of Unityper II Tapes)

The UNISERVO II

Purpose

The Uniservo II transports tape over a standard magnetic head (for reading and recording) under the control of Univac II.

Physical Specifications

The Uniservo is housed in a cabinet, the upper section of which contains the reel mounts and is covered by a removable glass door. The front panel doors are interlocked such that the center drive is stopped whenever the doors are opened. The entire front cover is easily removed, giving access to the loops.

Height	62 inches
Width	30 inches
Depth	30 inches
Working Space	6 ft 5 in x 5 ft 9 3/4 in.
Weight	650 lbs.

Operation

Input Function. A Uniservo may be used to read the coded, magnetic dots on the tape moving forward or backward and transfer the data in the form of electronic pulses to Univac.

Output Function. A Uniservo may be used to record the results of Univac processing in the form of coded, magnetic dots on a metallic tape or a mylar tape moving forward.

Reel Mounts. The reel mounts hold the standard 6 inch and 8 inch reels for magnetic tape and an 11 inch reel for mylar tape.

Tape Handling System. There are two independent servo systems - the two reel motor servos. The center drive is a magnetic clutch and the control signal to the clutch is supplied by Univac. The tape around the center drive hub is isolated from the tape reels by two loops of tape. The reel servos are controlled by loop size detectors.

The mylar spacer used on Uniservo I, has been eliminated on Uniservo II to accommodate the higher pulse writing density. A new hard surface to minimize head wear is being provided on Uniservo II.

Standard Magnetic Head. The standard magnetic head reads from or records in 8 channels. Seven of the channels are used for the 7-pulse code of the Univac System and the 8th channel is a sprocket channel.

Tape speed. 100 inches per second (nominal). Tape packing density 120 characters/inch.

Magnetic Clutch. Uniservo II is equipped with a magnetic clutch which provides the following:

Start-Stop time of 5 milliseconds maximum.
Reading or writing speed of 51 milliseconds for 720 characters (51 ms maximum to start, read 1 block, and stop).

Rewind of any number of Uniservos, up to and including 16, simultaneously.

Safety Switches. The Uniservo is fully equipped with safety switches which apply brakes to the reels if either of the 2 loops exceeds the prescribed length.

Control. The control of a Uniservo is maintained by Univac and exercised during a program by the following types of instructions:

- Read Forward
- Read Backward
- Record at high pulse density
- Record at low pulse density
- Rewind without interlock
- Rewind with interlock

Connection to Univac. As many as 16 Uniservos may be connected to Univac II at any one time. The connection is made by means of a sectional trough on the top of the line of Uniservos and continuing from the first Uniservo of the line to one corner of Univac. Uniservos may be electrically interchanged without effecting the program.

Power Requirements

The main power for the Uniservos is supplied by Univac.

USN ESO

Media	Speed
Unityper (Off-line: source document/Univac tape)	Keyboard
Card-to-Tape	240 cards/min (Off-line)
Uniservo (Tape Station) (On-line, read operation)	25 Kilocycle/sec

Commodity Stabilization Service

Off-line Equipment

1 Card-to-Tape Converter (80 column card)
2 Tape-to-High Speed Printers (600 lpm printers)
1 Bi-directional Paper Tape to Magnetic Tape (B-PTM-7)
1 Tape Cleaner
2 Unitypers

Metropolitan Life

Medium	Speed
Univac Card-to-Tape Converter	240 cards/min

Pacific Mutual

Uniservo II	100 inches/sec 250 char/inch

Very reliable with metallic tape. Input buffering of 60 words of magnetic core.

USS

Magnetic Tape	250 char/in 100 inches/sec

80-column card to magnetic tape converter. 300 cards per minute.

OUTPUT

Manufacturer

Media	
Magnetic Tape (Uniservo II)	20, 12.4, Or 5 Kc digit rate
Uniprinter	10 char/sec (20 char/in density)
High Speed Printer	600 lines/min (130 char/line, maximum)
Tape to Card Converter	120 cards/min (80 col cards)
Magnetic Tape to Paper Tape Conversion	60 char/sec (5, 6, or 7 channel)
Magnetic Tape to Magnetic Tape Transrecorder	90 char/sec (Speed dependent upon communication facilities)

USN ESO

Media	Speed
Tape-to-Card	120 cards/min (Off-line)
High Speed Printer	600 lines/min (Off-line)
Uniservo (Tape Station) (On-line, write operation)	25 Kilocycle/sec

Metropolitan Life

Univac Hi Speed Printer	600 lines/min
Univac Tape to Card Converter	120 cards/min

Pacific Mutual

Uniservo II	100 inch/sec 250 char/in

Very reliable with metallic tape.

Output buffering of 60 words of core. Can simultaneously read on 1 tape handler, write on a second and be rewinding a third.

USS

Magnetic Tape	250 char/in 100 in/sec
High Speed Printer	600 lines/min (Off-line)

Magnetic tape to 80-column card converter - 120 cards per minute.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	5,200
Tube types	20
Crystal diodes	18,000
Magnetic cores	184,000
Transistors	1,200
Separate cabinets	4

Above figures are approximate and do not include input-output devices.

CHECKING FEATURES

Checking Circuits

Whenever feasible, registers and other circuits appear in duplicate. Their contents are continuously compared so that inconsistencies between the data in the identical units give an indication of faulty operation, and stall the computer. At this point, the instruction may be repeated.

The pulse code used in the Univac System is so designed that all characters contain an odd number of pulses. At several strategic points within Univac, every character is checked for an odd number of pulses. An indication is given whenever an even number of pulses is detected, and the computer stalls. Other types of checking circuits cause Univac to stall when other types of errors occur.

An error occurs if reference to a non-existent memory address is attempted.

An odd-even error in the transfer rI to rM will result in a transfer stop and the location of the error (rI address) will be indicated.

The 720 character count will be displayed on a modulus 100 counter.

"All ones" checker. In addition to the parity bits check on the high speed bus, a second checker establishes that the invalid "all ones" character is not inadvertently created by a system fault.

Input and output checkers also detect the invalid "all ones" character.

Built-in checking features are contained in the Card-to-Tape Converter, the Tape-to-Card Converter and the High Speed Printer.

Fusing

Univac is completely fused in order that faults may be isolated. Each bay has its own set of fuses in addition to main fuses on all DC and AC potentials.

If a fuse blows, power is shut off and an indicator circuit shows in which bay the blown fuse is located, and a "flag" indicates the specific fuse.

Voltage Monitoring

An automatic voltage monitoring system continuously monitors all critical DC potentials giving an alarm if any moves outside the prescribed limits.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Univac has a separate power supply unit. The Univac II is designed to operate from a power service of 480 volts, 208 volts or 240 volts, three phase, 60 cycle. The system voltage must be specified in advance in order that the switch gear and 75 KVA transformer listed below may be properly supplied.

Power Requirement:

	Kw	KVA	PF
Motor Generator	47.3	59.2	0.8
Heaters	45.0	45.0	
Blower Motor	6.1	7.65	0.8
Standby, etc.	2.0	2.0	
Uniservo 16 x 1.5 Kw	24.0	30.0	0.8
	124.4	143.85	

Univac II Power System

The electrical power system for Univac II Central Computer and Uniservos consists of a packaged switchgear unit, a 75 KVA transformer, a 400 cycle motor generator set and a power supply unit. The power and control installation for the chilled water system and the peripheral equipment are discussed below. Wiring between units of the system is to be done by the user.

Switchgear. The switchgear unit controls the incoming power, the motor generator set supply and 400 cycle output circuit, the filament power and Uniservo power, and it is the center of all power control circuits. The main line circuit breaker will be supplied according to the system voltage. The motor starter will always be supplied for 480 volts. Dimensions: 8 ft 4 in wide; 30 in deep; 6 ft high.

75 KVA Transformer. A 75 KVA transformer, air cooled type, is supplied for mounting by the customer. If the system voltage is 480 volts the transformer will be 480/208 and connected between the main line circuit breaker and the filament power circuit breaker. If the system voltage is 208 volts the transformer will be 208/480 and connected between the main line circuit breaker and the motor circuit breaker. If the system voltage is 240 volts the transformer will be 240/480 and connected between the main line circuit breaker and the motor circuit breaker.

Motor Generator Set. The motor generator set consists of a 75 HP motor and two 25 KVA, 0.9 power factor 400 cycle generators. The motor is served by 480 volts, 3 phase from the switchgear. The 400 cycle output is controlled by electrically operated circuit breakers in the switchgear. Control of 400 cycle voltage and excitation for the generators is by the exciter regulator units in the switchgear.

Base 93 in long x 24 in
Overall 104 1/8 in long x 29 in
Area - 15.8 sq ft
Floor loading - 284 lbs/sq ft

Space Requirements

	Approximate Dimensions
Height	102 9/16 in.
Width	171 3/8 in.
Depth	94 3/4 in.
Working Space	16 ft x 22 in.
Weight	16,000 lbs

Univac contains thirteen bays of chassis. These bays are arranged in a structure resembling a letter "C". There are two bays at each end, five bays along one side and four bays and a door allowing access to the interior of Univac along the other side.

Each bay contains three-tiered sections. Each section contains twelve removable or plug-in type chassis. The chassis in each bay are accessible through doors which make up the casework. The core storage sections, however, contain 36 printed circuit chassis.

The inter-wiring between chassis is one the back boards of the sections and bays and is accessible from inside Univac.

Cooling System Requirements. The heat generated by the 5,200 vacuum tubes and the electronic components requires a cooling system. The Central Computer, Uniservos and power supply are cooled by a circulating chilled water system. 130 gallons per minute of 50° water are required. A three way mixing valve with controls and a circulating pump are required for the Central Computer and Uniservos. The power supply unit contains its own control. Water connections for the power supply may enter the cabinet either at the top or bottom. Water connections for the Central Computer and the Uniservos are at the sides near the floor and the piping may be run either on the ceiling or below the floor.

Refrigeration System Requirements. The Central Computer, Uniservos, and power supply units require 35 Tons of refrigeration.

USN ESO

Power, computer	190 Kw	190.5 KVA	0.95 pf
Power, air condit	75 Kw	75 KVA	0.9 pf
Volume, computer		1,200 cu ft	
Volume, peripheral equip		10,560 cu ft	
Volume, air cond & cooling tanks		1,200 cu ft	
Area, computer		1,636 sq ft	
Area, peripheral equip		1,056 sq ft	
Area, air conditioning		450 sq ft	
Room size, computer		49.5 ft x 33 ft	
Room size, peripheral equip		32 ft x 33 ft	
Room size, air conditioning		400 sq ft	
Floor loading		20 lbs/sq ft	
		250 lbs concen max	
Capacity, air conditioner		75 Tons	
Weight, computer		36,000 lbs	
Weight, peripheral equip		14,000 lbs	
Weight, air conditioner		3,000 lbs	
Total weight		53,000 lbs	

Building modifications consisted of trenching in floors to accommodate chilled water cooling system and power cables. Water supply and return with 100 ton cooling tower and basin installed on roof of building. 75 ton compressor to produce cold water for ADP equipment and room air conditioning. Duct work for room air conditioning is installed in regular ceiling. Existing power facilities were adequate to assume the load from ADP without modification.

Metropolitan Life

Power, computer	124 Kw	144 KVA	0.86 pf
Power, water cooler		25 Kw	
Volume, computer, 16 servos, power units		1,200 cu ft	
Area, computer, 16 servos, power units		250 sq ft	
Area, water cooler		900 sq ft	
Room size		2,000 sq ft	
Floor loading		10 lbs/sq ft	
		284 lbs concen max	
Capacity, water cooler		50 Tons per comp.	
Weight, computer		16,000 lbs	
Weight, water cooler		13,000 lbs	

Above figures are for each computer.

Walled room for motor-generator sets and voltage regulators and switch gear, fenced areas for tape storage, installed separate refrigeration equipment on 15th floor and water lines to computers on 20th floor, installed power lines from 15th floor transformers to 20th floor, dug channels in concrete floor for lines between electronic units.

Pacific Mutual

Power, computer	150 KVA 1.0 pf 3 phase
Room size, computer	1,500 sq ft
Floor loading	150 lbs/sq ft
Weight, computer	35,000 lbs

Installed special power lines to fourth floor site from special switchboard directly from street transformer. False ceiling primarily for esthetic purposes. Ducts installed for room air conditioning.

USS

Power, computer	221 Kw	246 KVA	0.90 pf
Power, air cond	90 Kw	106 KVA	0.85 pf
Volume, computer		70,630 cu ft	
Volume, air conditioner		28,996 cu ft	
Area, computer		7,063 sq ft	
Area, air conditioner		2,636 sq ft	
Floor loading		250 lbs/sq ft	
		250 lbs concen max	
Capacity, air conditioner		148 Tons	
		25,000 cu ft/min	

Converted warehouse to office-type space. Plenum chambers provided. Complete air filtering and air-conditioning. Installed ceiling lights, wall panels and tiled floor. 440 volt supply to switch gear. Equipment fed by conduit and cable racks.

COST, PRICE AND RENTAL RATES

Manufacturer (Original Prices)

Description	Base Monthly Rental 1 Shift 5 Day Week	Outright Sale Price F.O.B. Factory
Univac II Central Computer w/power supply & supervisory ctl desk	$18,540.00	$970,000
Uniservo II	450.00	20,000
Uniprinter	390.00	22,000
Extra Dolly Assembly for Uniprinter	122.50	7,000
Unityper II	90.00	4,500
Verifier	Not currently available	
High Speed Printer	3,300.00	185,000
Card-to-Tape Unit w/47 character code	2,520.00	142,100
Card-to-Tape Unit w/38 character code	2,500.00	---
Tape-to-Card Unit	2,300.00	130,000
Perforated Tape to Magnetic Tape (PTM) Converter	1,800.00	108,000
Magnetic Tape to Perforated Tape (MTP) Converter	1,500.00	90,000

The high speed printer and the card-to-tape unit with the 47 character code requires a customer furnished voltage regulator. Prices are subject to change without notice.

Rental charges include maintenance service, spare parts and test equipment. Separate maintenance contract and maintenance advisory service contract available to purchasers of Univac Systems.

USN ESO

	Prime Monthly Usage Rates
Central Computer w/12 Uniservos	$23,940
High Speed Printer	4,250
Card-to-Tape	2,540
Tape-to-Card	2,385
Unityper	90
Verifier	250

Metropolitan Life

4 Univac II's, ea, with 16 Uniservos, total $4,035,000.

3 Card-to-Tape Converters, 2 Tape-to-Card Converters, 3 High Speed Printers cost $1,345,000.

1 High Speed Printer rents at $5,000/month.

Maintenance service for 4 Univacs and auxiliaries cost $52,000/month.

Pacific Mutual

Unitypers, computer, servos and printer cost approximately $1.5 million.

Maintenance service is performed by own maintenance staff.

USS

Basic system includes two (2) Univac II Computers, twenty-eight (28) Uniservos, one (1) Unityper, and one (1) Unityper-verifier.

Additional equipment includes one (1) Card-to-Tape Converter, one (1) Tape-to-Card Converter, and two (2) High Speed Printers, with core buffers.

Equipment is rented. Maintenance is performed by the lessor.

PERSONNEL REQUIREMENTS

Manufacturer

The number of engineers, technicians and operators required depends upon the equipment complement of the Univac System and the shift operation.

USN ESO

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	U	R	U	R	U	R
Supervisors	5	5				
Analysts	7	8				
Programmers	16	20				
Clerks	5	5				
Librarians	1	1				
Operators	2	2	4	4	5	6
Engineers	4	4	6	6	8	9
In-Out Oper	2	2	4	4	6	6
Tape Handlers	1	1	2	2	3	3

The operators include the shift supervisor for each of the 1st and 2nd shifts.

Engineers are Remington Rand personnel included as part of the rental contract.

Operation tends toward closed shop.

Methods of training used include 8 weeks of classroom instruction plus 18 weeks of on-the-job training. Formal training agreements between ESO and Civil Service Commission.

Government wages in this line of work are not competitive with those being offered by ADPS users in industry and/or ADPS manufacturers. Skilled employees after 18-24 months training and experience in this field of work are showing a growing tendency to accept non-government employment.

Metropolitan Life

	One 8-Hour Shift Used	Recomm	Two 10-Hour Shifts 4 Days/Week Used	Recommended
Supervisors	4	4	6	8
Programmers	6	6		
Clerks	12	13		
Librarians	3	3		
Operators				14
In-Output Opera				24
Tape Handlers				4

Methods of training used includes suppliers classes for programmers and operators, occasional special classes run by programming coordinator, and on-the-job training for clerks, librarians, tape handlers, and in-output operators.

Machines work 20 hours per day, 6 days per week. Operators work 10 hours per day, 4 days per week.

Pacific Mutual

	Three 8-Hour Shifts Used	Recommended
Programmers	26	
Librarians	0	1
Operators	5	6
Engineers	9	9
In-Output Opera	4	5

Operation tends toward open shop.

Method of training used is basically on-the-job training with some formalized classroom work.

"Typical" personnel is difficult to recommend or give with great detail due to emphases and approaches to the problem. Each group must study their own problem and then work out the personnel set up.

USS

	Two 8-Hour Shifts
Supervisors	7
Analysts	33
Coders	2
Clerks	4
Operators	5
In-Output Opera	3
Tape Handlers	4

Methods of training used includes equipment manufacturer schools, internal schools, and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Reliability and operating experience based on the formula: (Available Operating Time minus Lost Time) divided by (Scheduled Operating Time). The cumulative performance reports for Univac I Central Computers have averaged 93.0%.

USN ESO

Average error-free running period 16 Hours
Good time 123 Hours/Week (Average)
Attempted to run time 136 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 1 Jul 59 to 30 Apr 60
Passed Customer Acceptance Test 1 Jul 58
Time is not available for rent to outside organizations.

Computer is normally run for 40 straight hours and then there is an 8 hour preventative maintenance shift before the next 40 hours.

The 10 per cent lost time includes losses as a result of tape; computer, operator, program and data error conditions.

Metropolitan Life

Good time 102.2 Hours/Week (Average) includ good rerun time
Attempted to run time 112.7 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.91
Above figures based on period from Jan 59 to Jan 60
Passed Customer Acceptance Test May 58
Time is not available for rent to outside organizations.

These Univacs were acquired under an option to convert Univac I's to Univac II's. The first Univac I was accepted in late 1954.

Pacific Mutual

Good time approx 100 Hours/Week (Average)
Attempted to run time 120 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) About 0.80 and improving.
Above figures based on period 1 Jan 60 to present
Passed Customer Acceptance Test 1959
Time is not available for rent to outside organizations.

USS

Good time 120 Hours/Week (Average)
Attempted to run time 137 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.87
Above figures based on period 14 Mar 60 to 9 Apr 60
Passed Customer Acceptance Test May 59
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Buffer Units

Input buffer (rI) 60 words of core storage. Input character rate up to 40,000 per second - dependent upon speed of Uniservos.

Output buffer (rO) 60 words of core storage. Output character rates of 20,000; 12,400; and 5,000 per second.

Transfer buffer (rW) 9 words of core storage. Cooperates with main memory during V and W instructions to transfer up to 9 words at 25,000 words per second. Transfer buffer (rZ) 60 words of core storage.

Control of Operation

Univac is controlled by instructions which are recorded on tape and read into the memory. The instructions are stored in successive memory locations beginning at 0000. Two instructions may be stored in each memory location.

Simultaneous reading, writing and computation are possible due to built-in buffer units. Univac can read from one Uniservo, write on a second and rewind all other Uniservos simultaneously. Unless there is another read, write or rewind instruction immediately following, Univac may continue to compute while reading, writing and rewinding operations are being performed.

Univac starts operating in accordance with the instructions stored in memory location 0000 and refers automatically to suceeding memory locations. Certain of the instructions read from the tapes the source data upon which the instructions operate and store the source data in the memory. Other instructions cause Univac to record the results of the operations on tape.

The operation of Univac is controlled by automatic sequencing. It may be interrupted by instructions that transfer the control of Univac from one memory location to another memory location not in sequence. This mode of operation conserves space in the memory

and requires a sub-routine to be stored only once in any part of the memory.

New Instructions

But for several minor exceptions, Univac II executes all Univac I instructions in exactly the same manner as Univac I. Certain of these instructions, however, have been assigned new functions which serve to extend their overall flexibility. The V instruction, for example, will now transfer from one to nine words instead of merely two as was formerly the case, and the Y-Z instructions will now transfer groups of words ranging from ten to sixty in number in steps of ten words. Formerly, ten words and only ten words could be transferred when using this instruction. As a further example of the greater flexibility permitted in Univac II, the extract function (or E instruction), formerly limited to register A, has been generalized so that it now covers all instructions which read out of the memory (A, B, D, L, M, N, P and S). The EF instruction permits recombination of selected characters from register A with the remaining characters of the word in memory location. Instruction A has been extended in usefulness also, and in addition, an I instruction (transfer from register L to memory) has been adopted as a standard command.

Overflow

With Univac II the addition of a 1 to the control counter reading following overflow is automatic. When using Univac I programs on Univac II a special switch will inhibit the addition of 1 to the control counter reading following overflow and cause the 3rd instruction digit to be interpreted in the memory switch as a decimal zero regardless of its actual value. Therefore, in Univac I programs where the 2nd and 3rd instruction digits have been used for overflow control, the presence of these digits will not influence the execution of the instruction.

Compatability Switch

A switch provides three circuit corrections to promote compatibility of Univac I and II programs. Any other incompatibility will require program corrections. With the switch in position to handle Univac I programs, the Univac II will treat the 3rd instruction digit as zero, for V, W, Z and Y instructions, treat the 2nd instruction digit as zero and restore the Univac I mode of overflow action on the control counter.

Tape Handling Operations

As many as 16 Uniservos may be connected to Univac by a metallic duct carrying the necessary cables. Univac can read from tapes mounted on these Uniservos with the tapes moving forward or backward. Univac can record on a tape moving forward. It can read from one Uniservo, write on a second and rewind all other Uniservos simultaneously. Unless there is another read, write or rewind instruction immediately following, Univac may continue to compute while the reading, writing and rewinding operations are being performed.

Tape recording for Univac II must be done according to the following:

Spacing per block	4.60 in
(with 1 in between blocks)	(3.60 in per block)
Pulse density per inch	200 nominal
Blocks per reel	4,000 (metallic) nominal
Read time per block	51 msec. minimum (metallic and mylar)
Per reel	3.4 minutes minimum (metallic)
Rewind time per reel	3.1 minutes (metallic)
Feet utilized	1,535 ft (metallic) 2,400 ft (mylar)

PROGRAMMING SPECIFICATIONS

Library and compiler routines for mathematical and commercial use, and service routines for maintenance uses, are available to the customer.

Modified or Added Instructions

I instruction providing for transfer of information from register rL to memory.

Field selection as specified by a second instruction digit F. For the instructions A, B, D, L, M, N, P and S it operates so that the word transferred from memory location M contains only those digits from the columns of "m" which correspond to the columns in register F containing "odd" characters. The remaining column positions of the word, transferred from "m" to the receiving register contain decimal zeros.

The EFm instruction permits insertion into a word in memory location "m" of the characters in those columns of register A which correspond to the columns containing "odd" characters in register F. "Odd" characters in the Univac code have a binary zero in the least significant binary position. rA will also contain the complete word which is restored at memory location "m".

Add to memory. The add to memory instruction is effected by adding a special designator (H) in the 2nd digit position of the A instruction. It results in the execution of an A instruction followed by an automatic H instruction. Register rA will retain the total (rX + rA) at the conclusion of the add to memory instruction. An equivalent subtractive operation is performed by the SH instruction.

Multiple Word Transfer

The Vn_1m_1, Wn_2m_2 word transfer instructions transfer one to nine words as specified by the numeric (n) appearing in the second digit position. Register rW provides the transfer storage. The transfer is made using V and W instructions as for Univac I except that no reversal of position occurs in a 2 word transfer as may in Univac I. Note also that if the second digits of the V and W instructions are not equal special transfers result. If $n_1 > n_2$. The first $(n_1 - n_2)$ words transferred from m_1 to rW are not transferred from rW to m_2. If $n_1 < n_2$. The $(n_2 - n_1)$ words transferred to rW by a previous V instruction are transferred to m_2 followed by the n_1 words of the current V instruction. When n = 0 the instruction will be processed as a skip instruction.

The Yn_1m_1, Zn_2m_2 pair of instructions permits the transfer of groups of 10, 20, 30, 40, 50, or 60 words as designated by a numeric (1 through 6) in the second digit position of the instruction. The Y, Z instructions use rZ as transfer storage. If the second digits of the Y and Z instructions are not equal, special transfers result. If $n_1 > n_2$. The first $n_1 - n_2$) tens of words transferred from M_1 to rZ will not be transferred to M_2. If $n_1 < n_2$. The $(n_2 - n_1)$ tens of words transferred to rZ by a previous Y instruction are transferred to m_2, followed by the n_1 tens of words of the current Y instruction. When n = 0, 7, 8, or 9, the instruction will be processed as a skip instruction.

Tape Writing Density Controls

5nm instruction causes writir of 200 pulses per inch except that manual countermanding pushbuttons will be provided to select one or more Uniservos on which the 5nm instruction will be interrupted as

calling for a 124 pulse per inch writing density. These manual pushbuttons will be in addition to those available for block subdivision and delta (Δ) second digit decoding of in/out instructions.

7nm instruction causes writing at 50 pulses per inch. Block subdivision controls will operate as in Univac I with all densities. Block divisions (space between blocks) will be 1 inch except for the 124 ppi density. This will be 2.4 inches.

Memory Clear

A protected switch will provide for memory clear (rM) to decimal zero. Register rM will clear on read-in.

Buffer Register Clear

Registers rO, rI, rZ and rW clear only on read-in.

Instruction Execution Time

Basic machine cycle is reduced from four to three cycles (α cycle is omitted).

All instructions are performed at minimum latency rates.

USN ESO

Outstanding features include self-checking of the computer through use of duplicate circuitry in both the arithmetic and logical units.

Standard tape labelling techniques are used; storage, shipping, protection from humidity, temperature and physical handling problems are minimal. System operates with metallic magnetic tape. Back-up master tape files are stored in a remote location as protection against loss of information through electrical, fire or other damage to the tapes stored in computer center library.

This activity has experienced a high performance rate in the use of metallic magnetic tape with its ADP system. A number of tests have been made with various types of mylar base tape; but, to date, the performance of mylar tape on Univac II is unsatisfactory.

Metropolitan Life

Outstanding features are that the system is completely self checking and simple to operate. Each tape is kept in a cardboard box, labeled on the reel and on the edge of the box, stored like books on open shelving with stall dividers every three reels, in locked fenced-in area. No special humidity, fire, or dust protection needed for metal tapes.

Pacific Mutual

Outstanding features include self checking and duplicated circuitry affording basically error free output. The Unitypers allow a complete tape system, completely devoid of any type of punch card.

If anything, we have erred in over controlling for everything except humidity, which we do not control.

We feel that for our job we have the best equipment presently available and are trying to keep aware of the next generation.

USS

Metal cases are used for ordinary filing. Fireproof cabinets for some master tapes.

PRODUCTION RECORD

Number of systems delivered 32

FUTURE PLANS

USN ESO

No new components or modifications to the installed ADP system are contemplated by this activity.

It is planned to retire the present ADP system and replace it with a more powerful, solid-state ADP system during FY 1962.

Several new applications will be programmed for processing, in addition to the applications already in production on the present ADPs, at such time as the replacement system is installed.

Metropolitan Life

Plan to get from two to four more systems of the 3rd generation type such as Honeywell 800, IBM 7080, etc.

Plan to extend tape files from present 6 million policies, to include other types for about 40 million policies, and expect to run these files daily instead of bi-weekly, and extend the area of operations performed.

Plan to be installing in many areas of work previously deferred because of lower expected savings and/or greater planning effort.

Pacific Mutual

We have gone from Univac I to Univac II and anticipate moving to Univac IIII - IBM 701 - Datamatic 801-RCA 501 or some other system as soon as the new generation of computer renders ours so obsolete as to be impractical to retain. This could conceivably be in 1963, 64 or 65.

We are continually investigating, modifying, etc., our system and equipment and looking to add new applications.

USS

Additional applications of the same type as currently processed will be installed.

New systems being reviewed and evaluated for consideration.

INSTALLATIONS

U. S. Navy Electronics Supply Office
Great Lakes, Illinois

U. S. Department of Agriculture
Commodity Stabilization Service
Kansas City, Missouri

Metropolitan Life Insurance Company (3)
1 Madison Avenue
New York 10, New York

Metropolitan Life Insurance Company (1)
315 Park Avenue So.
New York City, New York

Pacific Mutual Life Insurance Company
Pacific Mutual Building
Los Angeles, California

United States Steel Corporation
1509 Muriel Street
Pittsburgh 3, Pennsylvania

U. S. Department of Agriculture
Kansas City Commodity Office
Kansas City, Missouri

UNIVAC III

Univac III Data Processing System

MANUFACTURER

Remington Rand Univac
Division of Sperry Rand Corporation

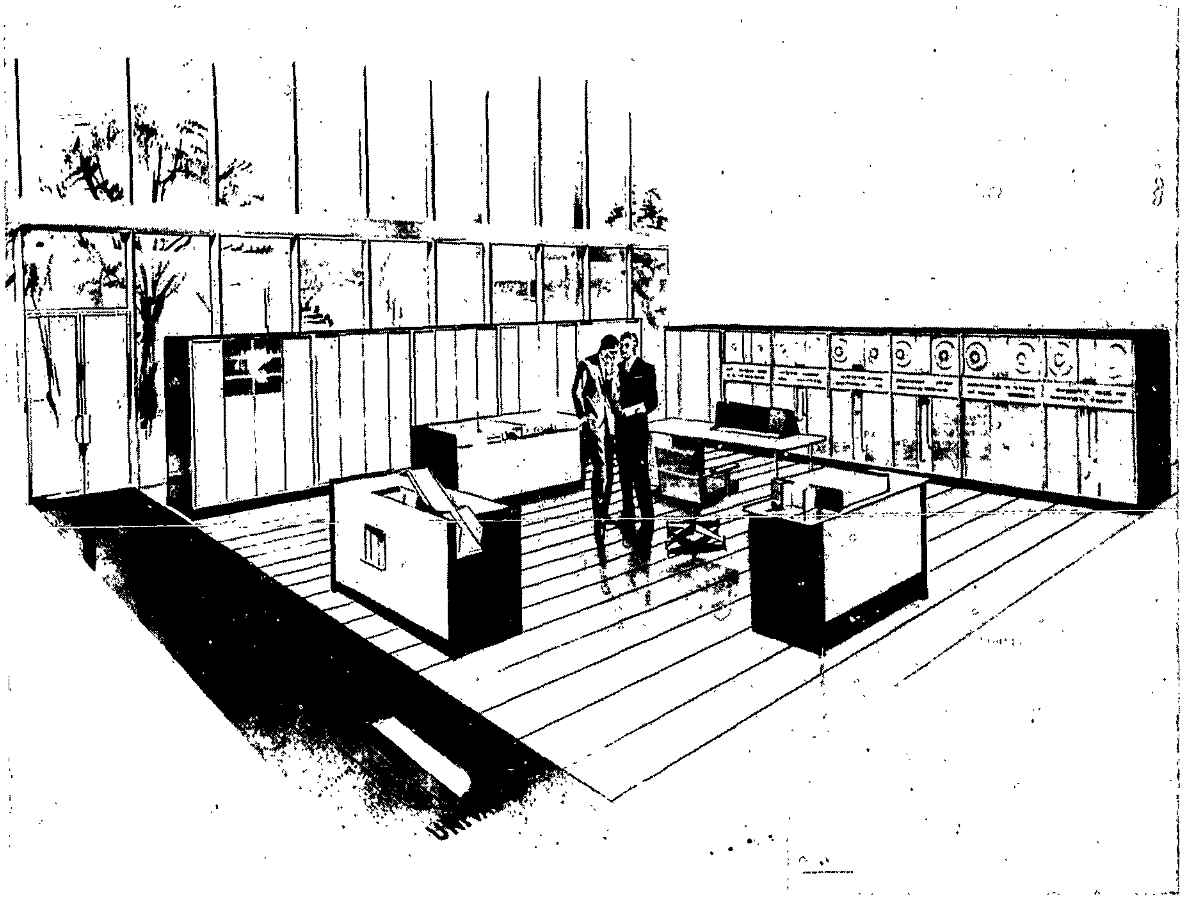


Photo by Remington Rand Univac, Division of Sperry Rand Corporation

APPLICATIONS

System is designed for commercial data processing as well as scientific applications. The UNIVAC III is a medium-cost, high performance electronic data processing system designed to meet the broadest possible needs of business and science. The magnetic core memory holds from 8,192 to 32,768 words in increments of 8,192 words each with a cycle time of 4.5 microseconds. Words can be pure binary, binary coded decimal, UNIVAC Xs-3, or any other form. UNISERVO III tape units allow reading, writing, and computing simultaneously. The read-write rate is 200,000 digits per second.

Up to thirty-two Uniservo III tape units and six Uniservo II tape units are possible. Auxiliary on-line units may include card-readers which operate at a rate of 700 cards per minute, high-speed printers at 700 lines per minute, card punch units at 300 cards per minute, mass storage and other devices. The UNIVAC III is compatible with other UNIVAC tape units or with those of other manufacturer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary or binary coded dec
Binary digits/word	24
Decimal digits/word	6
Alphanumeric char/word	4
Instructions per word	1
Instructions decoded	75 (approx)
Arithmetic system	Fixed point
Instruction type	one-plus-one
Number range	
Binary	$\pm (2^{96} - 1)$
Decimal	$\pm (10^{24} - 1)$

Instruction word format

Parity	Indirect Address or Field Select Opt	IR	Oper Code	AR/IR'	m Address
27 26	25	24 21	20 15	14 11	10 1

Automatic built-in subroutines includes automatic interrupt.

Automatic coding includes COBOL and assembly system.

Registers includes four accumulator registers, fifteen index registers, and thirteen memory address counters.

All instructions are automatically modified by the Index Register designated. System is able to select as an operand from one bit to ninety-six bits through use of a field select control word. From one to four-word operands are possible.

All users of UNIVAC III will be provided with a comprehensive programming package. The initial pack will contain COBOL, SALT Assy (Symbolic Assembly Language Translator), sort and merge generators, and an executive routine including contingency and error check routines.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec	
Add	8	8	6+6 Digits
Mult	48-124	48-124	6x6 Digits
Div	68-144	68-144	6/6 Digits

Arithmetic mode	Serial by digit
	Parallel by bit
Timing (Computer)	Synchronous
Operation (System)	Concurrent

The computer instruction execution cycle is such that the effective access time is zero.

STORAGE

Media	No. of Words	Decimal Digits	Access Microsec
Core	32,768	196,608	1.07
Drum (Mass Memory)	4,000,000/Drum	24,000,000	385

Magnetic Tape

No. of units that can be connected	32 Units
No. of chars/linear inch	1,333 Char/inch
Channels or tracks on the tape	9 Tracks/tape
Blank tape separating	0.68-0.78 Inches
Tape speed	100 Inches/sec
Transfer rate	133,300 Chars/sec
Start time	6.3 Millisec
Stop time	6.3 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Mylar

In addition to the units described above, a maximum of 6 Uniservo II may be included in the system. Check during writing on Uniservo III. Digital representation (4 bits) 200,000 pulses/sec transfer rate, 2,000 digits/inch.

INPUT

Media	Speed
Cards	700 cards/min
80 or 90 column. No plugboard	
Uniservo III	200 pulses/sec (Digital)
Up to 32 in system	133.3 (Alphanumeric)
Parallel read-write	
Uniservo II	25 pulses/sec (Alphanumeric)
For compatibility with other Univac Tape Systems	
Paper Tape	

OUTPUT

Media	Speed
Cards	300 cards/min
80 or 90 column. No plugboard	
Card Printing	Print - 900 lines/min
Punch	Punch - 150 cards/min
Punches and prints same card in one pass.	
High Speed Printer	700 lines/min
Editing program controlled.	
Paper Punch	

CHECKING FEATURES

Modulus 3 word parity checking, arithmetic, transfer and comparison operations, and logical checks.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	75.2 Kw 94 KVA 0.80 pf
Volume, computer	900 cu ft
Area, computer	1,500 sq ft
Room size	43 ft x 43 ft x 12 ft
Floor loading	200 lbs/sq ft
	1,100 lbs concen max
Weight, computer	27,225 lbs

Heat exhaust vents should be located at roof of each unit. Air conditioning output ducts should be near unit inlet vents. Total input line current 261 amperes/line. Recommended main circuit breaker 400 amperes/line. 115 volt convenience outlets should be located every 6-8 ft approximately 2 1/2 ft off floor.

These figures include the Univac III large system w/16 tape.

PRODUCTION RECORD

Number on order	25
Time required for delivery	18 months

COST, PRICE AND RENTAL RATES

Basic System Units	Price	Monthly Rental
Computer - 8 K Memory	$390,000	$ 8,000
High Speed Reader	35,000	750
Punch Unit	40,000	850
High Speed Printer	79,000	1,650
Uniservo III Synchronizer-Max. 16 Uniservos	145,000	2,900
Uniservo III Power Supply	17,500	350
Uniservo III	24,000 ea.	500 ea.
Additional Equipment Units		
Card Punching Printer	$ 197,500	$ 4,300
Uniservo II	20,000	450
Uniservo II Synchronizer	92,500	1,925
Uniservo II Power Supply	17,500	350
Memory-Add. 8 K -	67,500	1,400
Add. 24 K	193,500	4,030
Second Uniservo III Synchronizer or Mass Memory Device	145,000	2,900

Maintenance/service contracting is included in rental price.

PERSONNEL REQUIREMENTS

Training made available by the manufacturer to the user includes a program-systems course for experienced programmers of 5 weeks duration and for inexperienced programmers of 8 weeks duration.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The system is completely self-checking.

ADDITIONAL FEATURES AND REMARKS

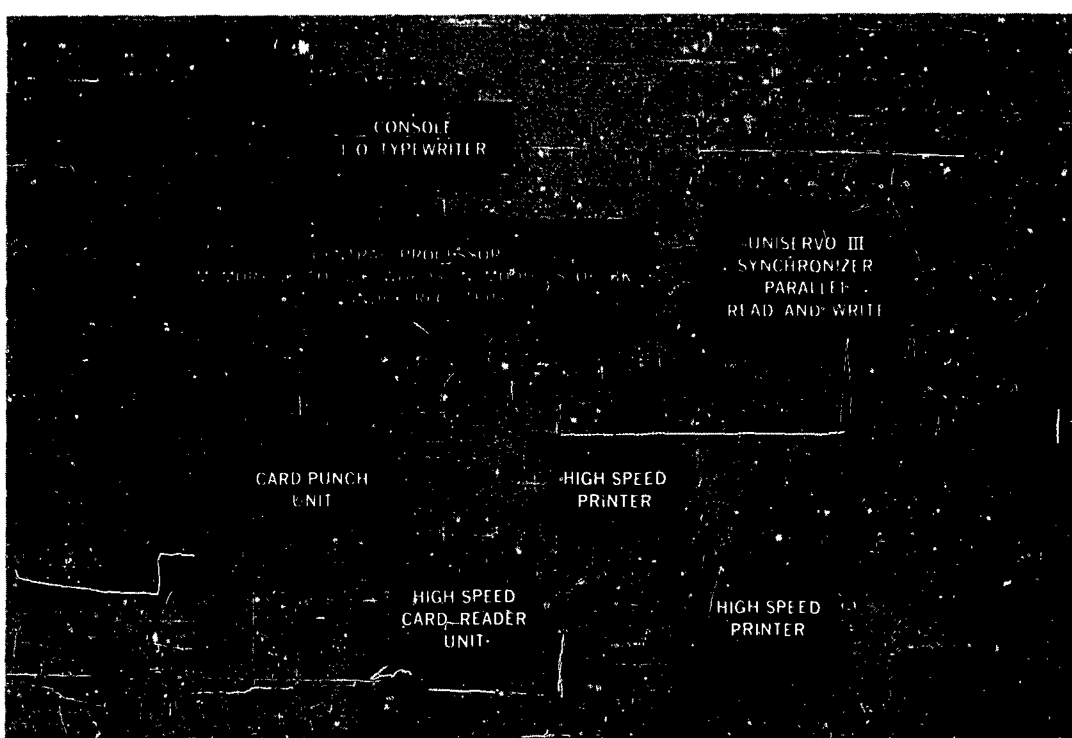
Outstanding features are modularity, field selection, multiple word operand, index registers, scatter-read-gather write, and indirect addressing.

Unique system advantages includes automatic interrupt, combined with above features.

The normal procedures for handling Mylar tape may be used.

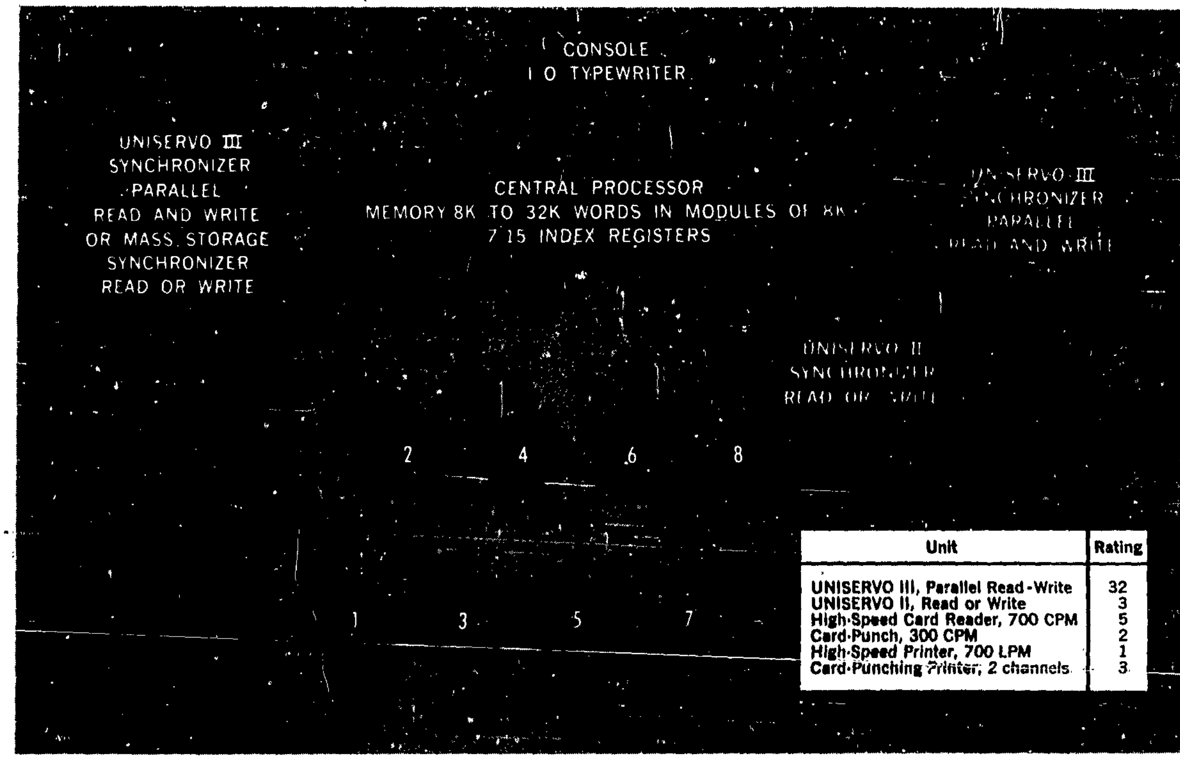
A one addressable modulus 24 hour clock is included. It keeps time in tenths of a second and has a digital output which can be read by the computer program.

As faster components become available and more powerful input-output units are developed, they will be incorporated in this system without requiring program changes.



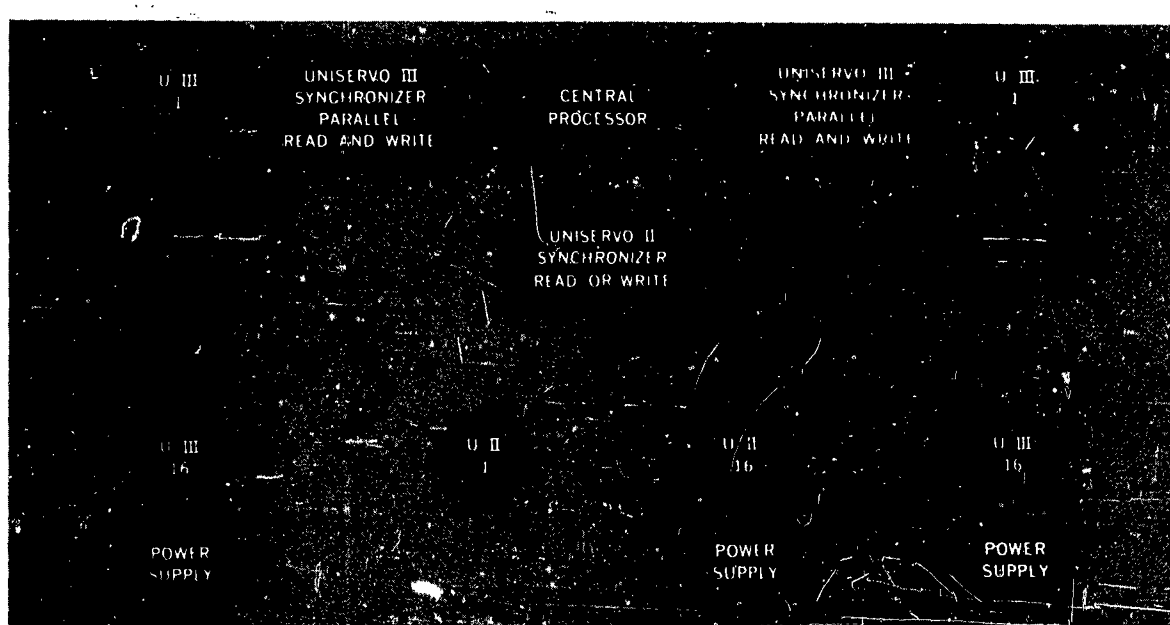
Typical Basic System

Diagram by Sperry Rand Corporation, Remington Rand Univac Division



Unit	Rating
UNISERVO III, Parallel Read-Write	32
UNISERVO II, Read or Write	3
High-Speed Card Reader, 700 CPM	5
Card-Punch, 300 CPM	2
High-Speed Printer, 700 LPM	1
Card-Punching Printer, 2 channels	3

Typical Expanded System



Tape Line Configurations

Diagram by Sperry Rand Corporation, Remington Rand Univac Division

UNIVERSAL DATA TRANS

MANUFACTURER

Universal Data Transcriber

Naval Weapons Laboratory
Dahlgren, Virginia

Photo by U. S. Naval Weapons Laboratory, Dahlgren, Va.

APPLICATIONS

Located at the Naval Proving Ground, the system is used for conversion of scientific or management data from one medium or format to another, primarily in the processing of input and output for the NORC or other computers.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36
Binary digits/character	8 + 1 check bit
Instruction word format	

M0	M1		M2	M3
8 1	8 6	5 1	8 1	8 1
Operation Code	B-Register Specification	Address Specification of Reference to Memory		Limit Value of Bx

Since there are no multiply or divide orders, the operating binary point may be considered to be in any convenient location. The carry (borrow) bit may be propagated from character to character in addition (subtraction) with use of double precision orders. A single reference to the memory brings out four characters designated as M0, M1, M2, and M3 into the memory register. Addresses evenly divisible by four always correspond to the character read out as M0. Instruction words consist of the four characters M0, M1, M2, and M3. Instruction words are logically divided into 4 fields as shown above, namely: Operation Code, B-Register specification, Address Specification of reference to memory and the Limit Value of Bx.

The operation of the system depends upon the micro-programming of the computer to generate special orders which will transfer data from the particular external input device currently in use to the computer memory and from the memory to the external output device currently in use. The use of micro-programming, which is accomplished by use of a plugboard, allows an efficient transfer of data between the computer memory and the external devices with a minimum of special equipment. Conversion of the data within the memory from one form to another is accomplished by

the use of an appropriate stored program. This gives a very flexible system since all that is required to change the system from one job to another is to change the connections to the external equipment, insert a different plugboard, and load a new program into the computer memory. This system was conceived, designed and is under construction by the Computer Research and Development Branch of the Computation and Exterior Ballistics Laboratory of the U. S. Naval Proving Ground, Dahlgren, Virginia.

The system registers are:

1 Input register
1 Output register
2 Computing registers
6 B-registers (address modifiers)
1 Instruction register
1 Instruction counter
Indicator latches (single bit registers)
Other special registers

External devices communicate with the computer via the input and output registers under control of the computer. The input register can select at high speed from either of two different external devices. The output register is normally connected to only one unit. Indicator latches are used both to control the external devices and to signal the condition of the external devices to the computer. Special electronic signal generating equipment tailored to each type of external device is used to facilitate communication with the input register, output register, indicator latches and the external device.

CHECKING FEATURES

The computer has automatic circuitry built into the system to check the accuracy of its operation. This check adds a parity bit to the 8 bits in each character so that the modulo two sum of the binary one's of these 9 bits is always odd. This check bit is generated after data enters the input register, is corrected as the characters are modified by various orders, and is stored in the memory along with the character. An automatic check is made for the presence of the proper parity count as the data is transferred from the memory into the working registers or the instruction register. The values in the B registers are checked automatically as they are used and there are checks on the execution of the overlay and shifting operations in the computing registers.

Whenever possible checks will be made on the accuracy of data transmission between the computer and the external devices. For example, in card reading, data will be loaded into two independent shift registers from two reading stations, and after the card images are assembled in memory they will be checked against each other. In punching data into cards, the card will be read back into the computer after being punched and this card image will be checked against the card image sent out to the punch. When magnetic tapes are written the data will be read back into the computer and a check will be made on the correctness of the data.

ARITHMETIC UNIT

Operation time, incl 1 memory access	11 microsec
Operation time, incl 2 memory accesses	21 microsec

Two memory accesses are required for such orders as read out and store orders.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	2,048	36 bits/word	10

INPUT OUTPUT

Media	Speed
Magnetic Tape (NORC)	70,000 dec dig/sec
Magnetic Tape (Potter 906)	37.5/75 in/sec 200 char/inch
Paper Tape (Digitronics)	300/600 char/sec (read)
Paper Tape (Teletype)	60 char/sec (read)
Paper Tape (Flexowriter)	10 char/sec (read)
Paper Tape (Teletype)	60 char/sec (punch)
Paper Tape (Flexowriter)	10 char/sec (punch)
Magnetic Tape (Analogue, Ampex Model FR-100A)	
Speeds are 1.875, 3.75, 7.5, 15, 30 and 60 in/sec.	
Cards (Remington Rand)	450 cards/min (read)
Cards (Remington Rand)	100 cards/min (punch)
Cards (IBM Model 101)	450 cards/min (read)
Cards (IBM Model 514)	100 cards/min (punch)
Typewriter (Flexowriter)	Keyboard (entry)
Typewriter (Flexowriter)	10 char/sec (print)

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	5 Kw	6 KVA	0.83 pf
Room size, computer		480 sq ft	

No special preparation. Air conditioned as a small part of a large system.

PRODUCTION RECORD

Number produced	1
Number in operation	1

COST, PRICE AND RENTAL RATES

Total approximate cost $350,000 for all units listed except IBM 101 and 514, which are rented.

PERSONNEL REQUIREMENTS

	Three 8-Hour Shifts
Programmers	3
Operators	4
Engineers	1
Technicians	1

Operation tends toward closed shop.
Methods of training used is on-the-job.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Time is available for rent to qualified outside organizations. System has been in use on several projects since January 1960. Some engineering work continues. It may be used by government agencies or contractors when time is available.

ADDITIONAL FEATURES AND REMARKS

The most outstanding difference between the computer of the Universal Data Transcriber and any other single address binary computer is the availability of the plugboard and the plugboard instructions. The plugboard is divided into three regions. The first region consists of information coming from equipment in the computer to the plugboard. This includes all of the registers, such as Register 1, Register 2, Input Register, Output Register, Instruction Register, Instruction Counter, B7, and the indicator latches, plugboard instruction specification and the internal clock. Also in this region are external inputs from the various input and output devices which have been converted to the proper signal levels. The second region of the plugboard consists of a set of approximately 75 logical packages. These packages are identical to those used in the construction of the rest of the computer. In the third region of the plugboard are exists from the plugboard of the control lines in the computer. These lines control the transfer of data from "register to register", use of the B Registers, controlling memory cycles, setting of indicator latches, shifting various registers, etc. Thus by using all three regions of the plugboard almost any conceivable (or desirable) cycle of actions can be controlled from the plugboard. This feature is primarily for use with external devices to get data to or from them and the memory of the UDT.

The indicator latches in the computer are used primarily for communication between the UDT and external devices. For example, some of the indicator latches could be wired, via the plugboard, to control the stopping, starting, or reading or writing of a tape unit. Other indicator latches could be used to indicate to the UDT that an external device is in certain conditions, for example, that a card reader is moving cards, or ready to scan one row of information, or that it is out of cards, etc. Thus the program can control external devices, and external devices can be sensed by the program by use of the indicator latches.

Another feature of the UDT is the "Program Interrupt" ability. If a particular exit on the plugboard is energized the computer will go into a program interrupt cycle. This exit can be energized from an indicator latch, or combinations of indicator latches and various conditions by wiring on the plugboard. When this condition occurs the computer will automatically make a program transfer to instruction location 4 at the end of the current instruction. The address (Y) of the instruction which would have normally been executed next, if the program interrupt condition had not occurred, will be automatically stored in character locations 1 and 2 in a form so that if the character in location 0 is the code for a program transfer (jump) command and the instruction at location 0 were to be executed, the computer would jump to the proper address (Y). When this feature is used the program, starting at location 4, must be suitable to take the appropriate action for the condition which caused the jump. After this is done, the program would normally remake the appropriate registers, and then jump to location 0, which would cause the jump back to the main program at the proper place. By using this feature the computer can react rapidly to external control information without requiring repeated sensing on the condition.

The major advantage of the Universal Data Transcriber is its flexibility. It is not tailored to any specific computer or type of data conversion and is therefore not likely to become obsolete as fast as many specialized converters. The micro-programming and stored program features makes it easy to implement almost any desired conversion with a minimum of engineering effort and special equipment. The major disadvantage to this approach is that it is more expensive than any single specialized converter.

To establish the capabilities of the Universal Data Transcriber several preliminary programs have been prepared. One program for converting 80 column alphanumeric IBM cards to NORC magnetic tape provides for arbitrary code and format conversion, specified by header cards, and converts data to magnetic tape at a rate of 450 cards per minute. Similar programs have been developed for conversion from one magnetic tape system to another. If there is a conversion in both the code representation of the data and in the format, but not in the number base, the system can convert 4, 5, 6, 7, or 8 bit characters from one form to another at a rate of approximately 3,000 characters per second. Conversion can be made from 48 bit binary words to decimal digit words at a rate of approximately 16 words per second. Conversion can be made from 13 digit decimal words to binary words at rates in excess of 50 words per second.

The Universal Data Transcriber is being designed and constructed at the U. S. Naval Proving Ground, Dahlgren, Virginia. Subcontractors are providing the memory, logical building blocks, and various specialized input and output circuitry.

The logical building blocks are all transistorized megacycle SEAC type circuitry built by Computer Control Company. Some of these are being modified to provide two phase operation where the extra speed is required. The memory is an all transistorized magnetic core memory with a full read-write cycle time of 10 microseconds, and operates in parallel on a 36 bit word or 4 characters of 9 bits each. The 80-brush reading station of the IBM 101, used as a 450 card per minute reader, will load the data from a row in the card in parallel into a magnetic shift register which will be shifted into the computer on four wires in 600 microseconds. A similar circuit will be used on the second reading station so as to provide a check on the reading. Data is punched into IBM cards at 100 cards per minute by serially shifting, one bit at a time, at a 100,000 cycle shift rate, the 80 bits in the row to be punched. This shift register will pick up relays which will control the punch magnets in an IBM 514. The reading station which follows the punching station will be equipped with magnetic shift register for reading back the data from the punched card for a check. The same shift register and relays which are used in punching is 120 bits long so that it can be used to control the printing on an IBM 407. A Flexowriter is permanently attached to the system to provide communication between the computer and the operator and is used as an input for the program tapes, and as an input or output of 5, 6, 7 or 8 channel paper tape. A NORC magnetic tape unit is used to provide communication

to or from the Naval Ordnance Research Calculator.

INSTALLATIONS

Computation and Analysis Laboratory
Naval Weapons Laboratory
Dahlgren, Virginia

VERDAN

Autonetics VERDAN MBL-D9A Computer

MANUFACTURER

Autonetics
Division of North American Aviation

APPLICATIONS

The computer is used in real time control systems, such as inertial navigation, bombing, weapon system central digital computer, flight control, ground checkout and alinement, and process control.

As a data system, it is used for scientific computation, impact predicition, and mission readiness.

The VERDAN computer consists of three interconnected computational centers: (1) an incremental or DA section (2) a whole valve or GP section and (3) an input-output section. All three centers may be operated simultaneously. The GP section directs all computation.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	24
Binary digits/instruction	22
Instructions/word	1
Instructions decoded	52
Arithmetic system	Fixed point
Instruction type	One and 1/2 address format

Number range
As an integer: $-(2^{23}) \leq W < (2^{23}-1)$
As a fraction: $-1 \leq W < 1 - 2^{-23}$

Instruction word format

0 1	2 8	9 12	13 16	17 23
Not Used	Sector of Next Instruction	Operation Code	Channel	Sector
			Operand Address	

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	160	80
Mult		2,000
Div		2,000

Construction (Arithmetic unit only)

Transistors	1,500
Diodes	10,670
Resistors	4,500
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

The clock rate is 332.8 kilocycles/sec. Above information is for the G.P. only.

STORAGE

Medium	No. of Words	No. of Bin Digits/Word
Rotating Disc Memory	1,664	24

The average access time is one half of a disc revolution, or 5 milliseconds.

Magnetic tape is under development.

INPUT

Media	Speed
16 DC Voltages (± 0.5% Range ±10V)	100 times/sec
3 Ternary Coded Pulse (using 8 integrators)	800 times/sec
32 Shaft Encoder (20 significant bits)	100 times/sec
3 Resolver Incremental (using 8 integrators)	800 times/sec
Tape Reader	
Manual Control	

OUTPUT

Media	Speed
15 DC Voltages	100 times/sec (±0.5% Range ±10V)
Serial Digital	332.8 bits/sec
16 Shaft Encoder	100 times/sec (20 significant bits)
4 Bin Code	100 times/sec
4 Ternary Code	100 times/sec
Nixie Display on control panel	
Paper Tape Punch	5 channel
Typewriter	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	10,000
Transistors	1,500
Capacitors	670
Resistors	4,500

CHECKING FEATURES

Parity on input-output. The same problem can be run on GP and DDA internally and answers compared.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.320 Kw 0.8 pf 400 cycle, 3 phase
Volume, computer	1.4 cu ft
Weight, computer	82 lbs

Air conditioner is not normally required if input air is between 0°F and 90°F. Blower must be supplied by user.

PRODUCTION RECORD

Number produced to date	180
Number in current operation	180
Number on order	883 (approx.)
Anticipated production rates	5/week
Time required for delivery	10 months

COST, PRICE AND RENTAL RATES

Basic system consists of the computer - VERDAN, manual control panel, and paper tape reader. Additional equipment includes paper tape punch, tape prep. equipment, test equipment - C297A, and typewriter. Prices are available upon formal request to Autonetics.

PERSONNEL REQUIREMENTS

This computer was primarily designed for unmanned control systems and thus can operate for long periods of time unattended.

Training made available by the manufacturer to the user includes programming course and operation and maintenance course.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Calculated mean time before failure, from parts count, is 160 hours. Realized MTBF under steady state operation is 250 hours.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include multiple input-output, combination GP/DDA, and small size.

Due to the manner in which the inputs and outputs are handled - internally - the computer does not halt while inputing or outputing, thus the GP, DDA and input-output operations can proceed simultaneously, making this machine almost ideally suited to the real-time control problem.

The VERDAN contains a non-volatile magnetic memory. Provisions are incorporated such that in case of power failure, all intermediate information is stored on a memory channel. Upon resumption of power, the flip flops and registers etc., are reset and the program computation resumes at the point of interruption.

FUTURE PLANS

A digital, addressable magnetic tape reader and writer is under development as an accessory for this machine, in order to extend its capabilities.

INSTALLATIONS

Autonetics
Division of North American Aviation
9150 E. Imperial Highway
Downey, California

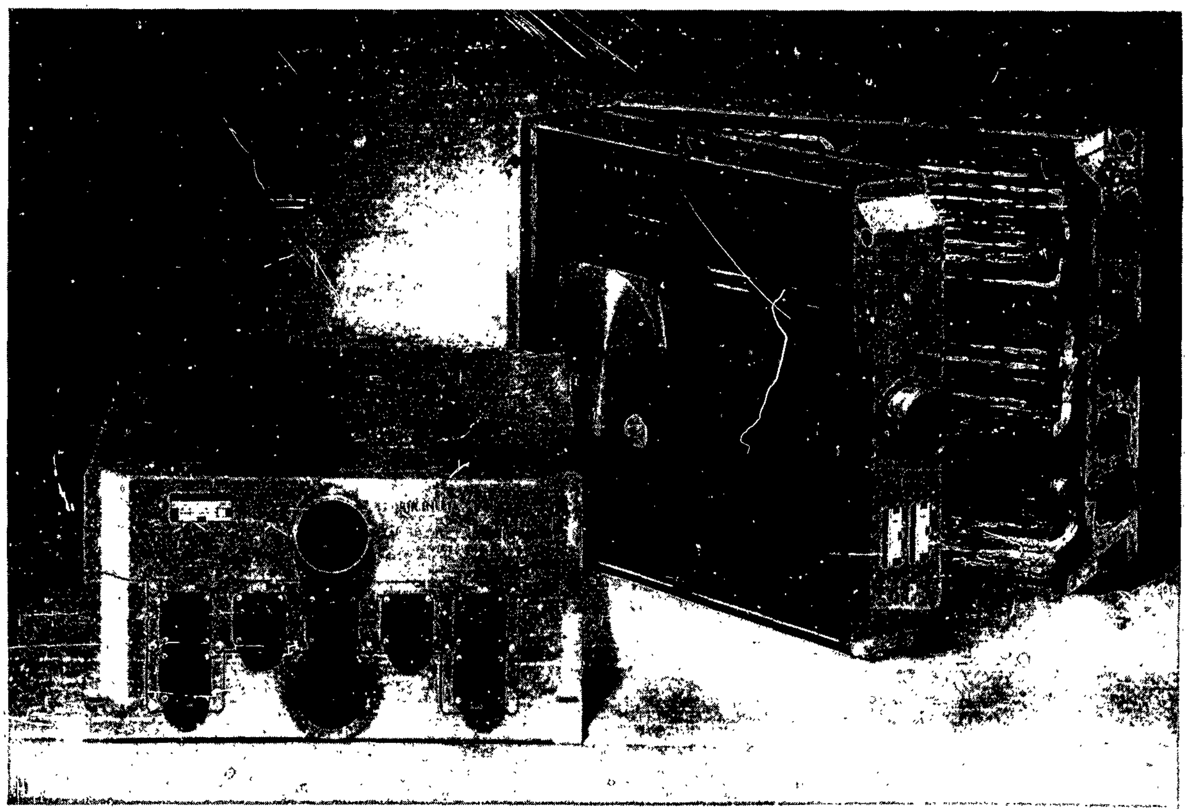


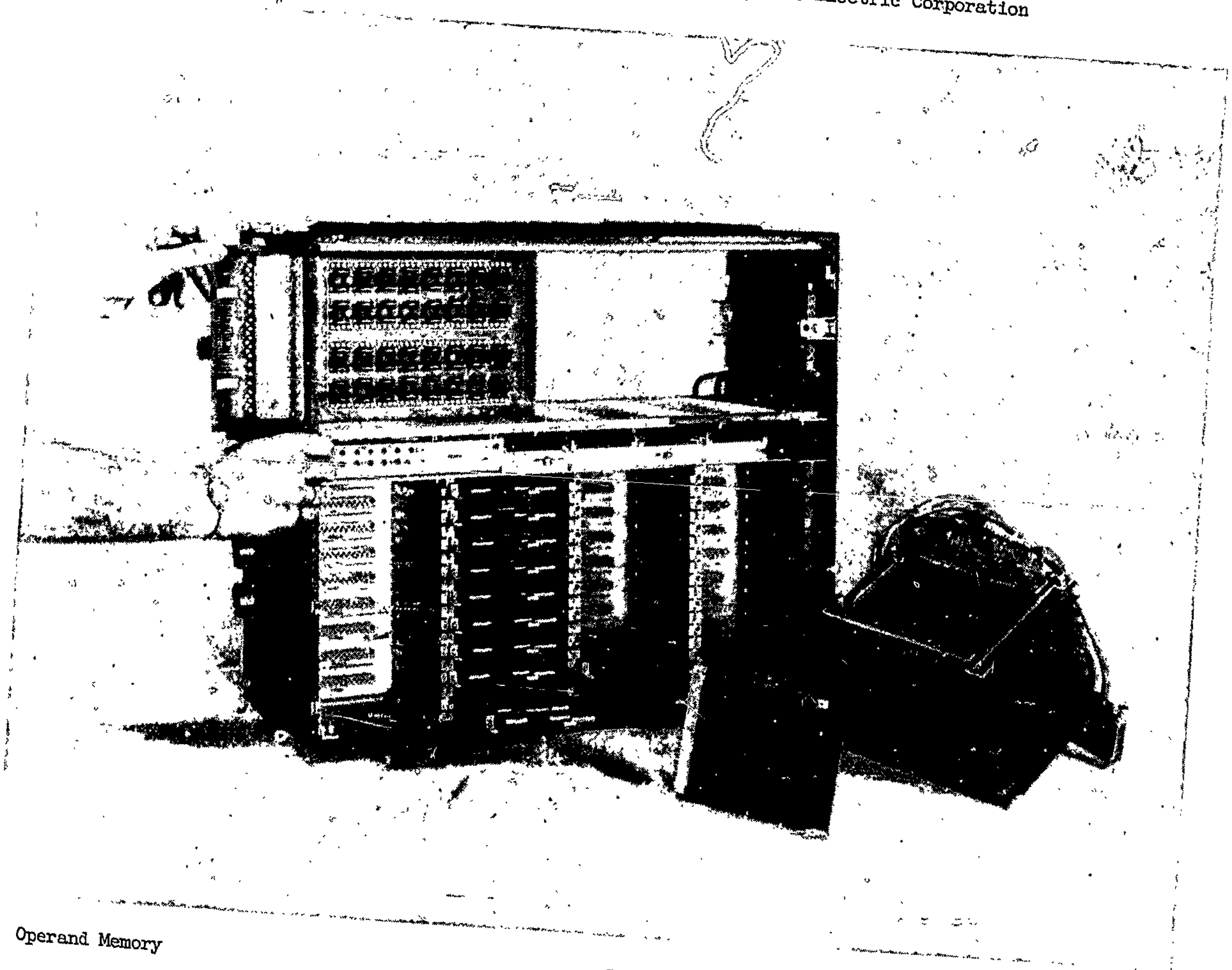
Photo by North American Aviation, Inc., Autonetics Division

WESTINGHOUSE AIRBORNE

Westinghouse Airborne Digital Data Processor

MANUFACTURER

Air Arm Division
Westinghouse Electric Corporation



Operand Memory

Photo by Westinghouse Electric Corporation

APPLICATIONS

System is used to process radar data, generate synthetic displays, and direct antenna. The computer is used also to conduct built in system tests, perform diagnostic tests of the Data Processor itself and generate calibration displays.

The Westinghouse Airborne Digital Data Processor is a problem oriented general purpose digital computer developed by Westinghouse for the Bureau of Aeronautics. Problem orientation of the Data Processor stems from its function as a sub-system of a radar processing system with multiple target handling capability.

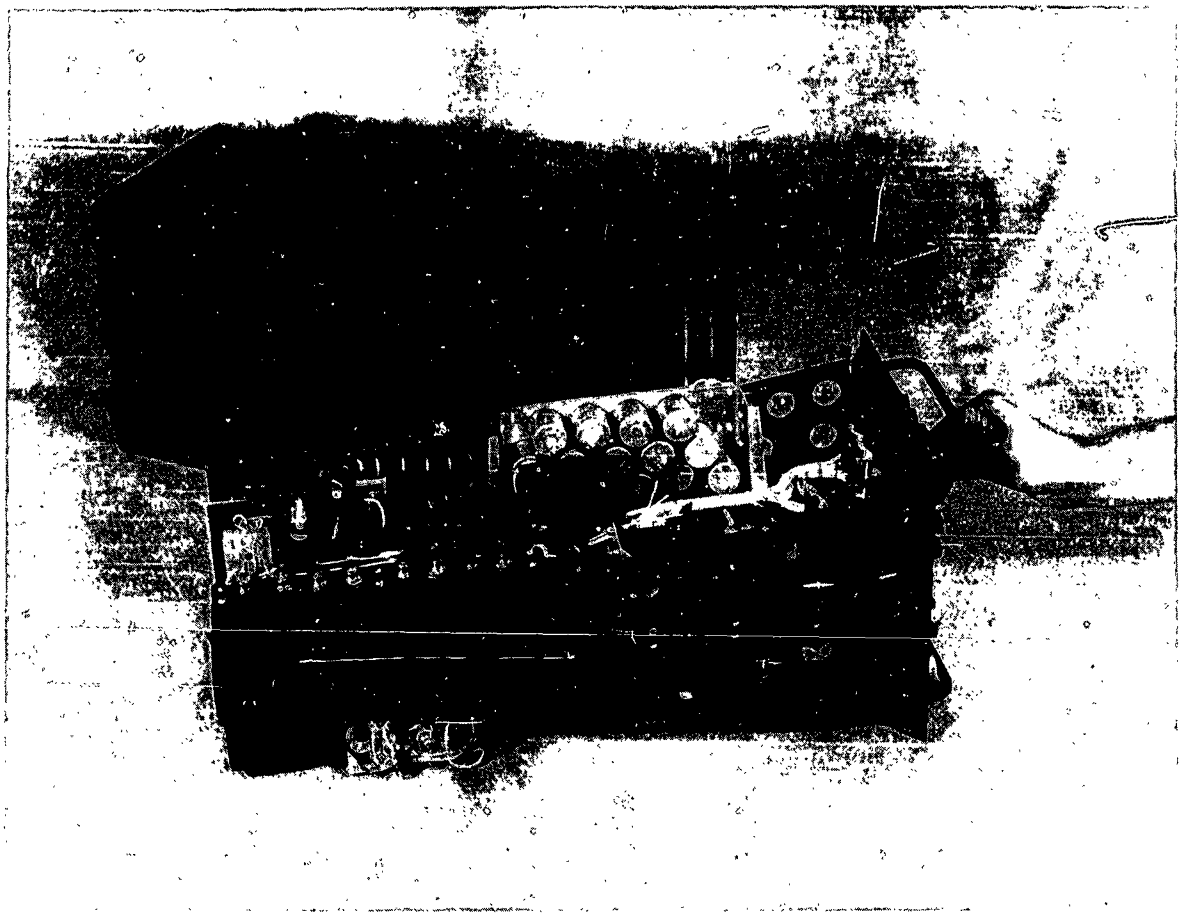
PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	24
Binary digits/instruction	21
Instructions/word	One (two instruction words per memory line)
Instructions decoded	4096
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-1 < n < +1$

Instruction word format

21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Inst. Field					Index		Address Field													

Field Designation for Instruction Word



Power Supply | Photo by Westinghouse Electric Corporation

Registers and B-boxes

Accumulator	X-Register
Q-Register	3 Index Registers
M-Register	IS-Register

Stored Data Processing program consists of many sub-routines.

Data-constant words are expressed in a complement form. Operand words are stored two words per operand memory line. Programmer has choice of left or right word, left or right half of left word, or left or right half of right word. These choices provide for maximum use of data locations.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	3	1.4
Mult	20	20
Div	40	40

Construction (Arithmetic unit only)

Transistors	2,600
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

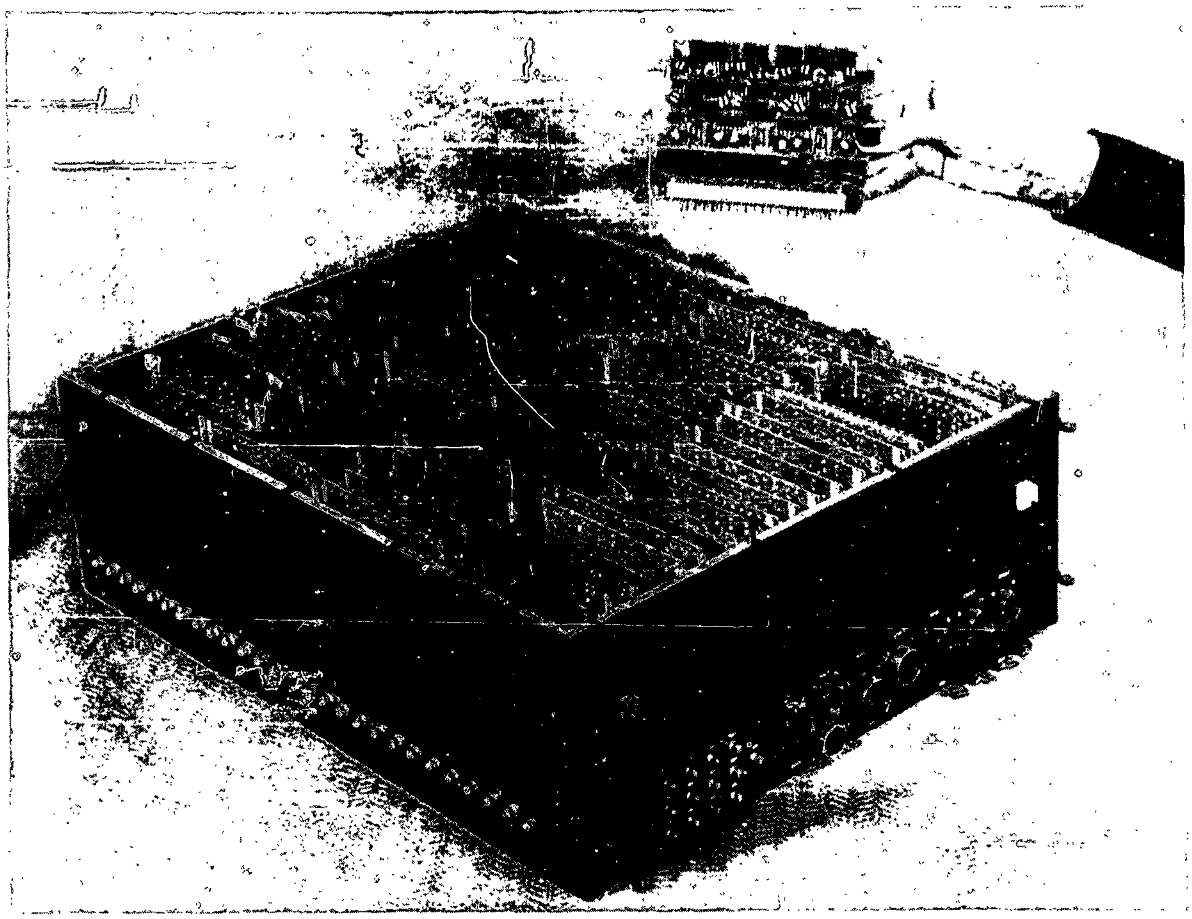
Media	No. of Words	No. of Dig/Words	Access Microsec
Magnetic Core	4096 Inst Words	21	0.2
Magnetic Core	1024 Oper Words	24	0.8

Magnetic Tape

No. of units that can be connected	1 Unit
No. of characters/linear inch	200 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Tape speed	75 Inches/sec
Start time	3 Millisec
Stop time	3 Millisec
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Mylar

Selected data recorded on tape compatible with IBM 727 tape unit.

Provides checking feature for processed data.



Input Unit

Photo by Westinghouse Electric Corporation

INPUT

Media	Speed	
Hi-speed Block Transfer	3 microsec/data word	
Voltage to Digital	75 microsec	0.1% Resolution
Sense Inputs	3 microsec	

Special input unit designed to receive information from radar and present it to Data Processing units.

OUTPUT

Media	Speed
Hi-speed Block Transfer	3 microsec/data word
Digital to D-C Voltages 0.1% Resolution	15 microsec read-out
Digital to A-C Voltages 0.2% Resolution	9 microsec read-out

Special output unit designed to receive data from the arithmetic/control unit, decode data, output to the antenna director, display of tracked targets on console, and output to tape unit.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	15,985
Transistors	7,597
Magnetic Cores	113,600

Gating systems operate on DC levels with approximately 10 millimicroseconds of delay per stage.

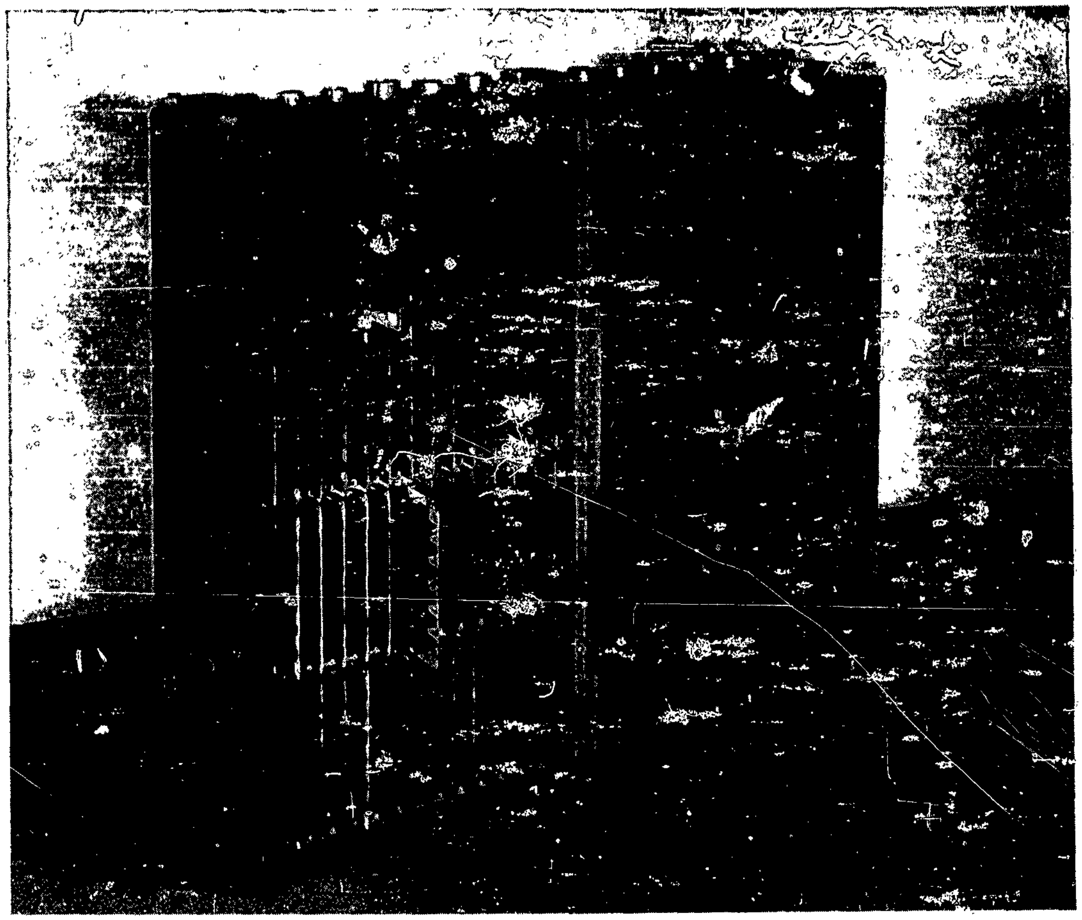
Multi-aperture core Instruction Memory with Non-Destructive Read-out.

CHECKING FEATURES

Internally Programmed Self Test

Arithmetic/control monitor capable of testing and holding the contents of a particular register at any prescribed time.

Readily accessible test points permit rapid trouble shooting without removing cards or units from mounting structure.



Arithmetic/Control Unit Photo by Westinghouse Electric Corporation

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer and power 1.8 Kw 1.8 KVA 1.0 pf
Volume, computer 6.5 cu ft
Area, computer Dependent on mounting application
Weight, computer 250 lbs

Data Processor is designed for airborne use. Mounting structure depends on space available. Cooling required is a blower with a capacity of 200 cfm at max amb temperature 38°C min air density .052 lbs/ft^2. System requires 115v, 400 cycle, 3-phase, 600 watts/phase, or 28v D.C. 3 wire.

PRODUCTION RECORD

Number produced to date 2
Number in current operation 2

Current operating models are prototype.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by the manufacturer to insure required reliability include selected standard parts proven long life items with extensive life testing operations, electrical components derated to operate at 20% of nominal voltages and power ratings, and circuits designed to accomodate wide swings in component parameters.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include Hi speed (300,000 operations/sec) in a ruggedized, small package, high reliability, and general purpose command repertoire with three Index Registers.

Unique system advantages include Non-Destructive Instruction Store with 1 microsecond memory cycle time, and split word storage, allowing programmer a choice of a 24 bit whole word or a 12 bit half word.

INSTALLATIONS

Westinghouse Electric Corporation
Air Arm Division
Avionics Systems Section (454)
Box 746
Baltimore 3, Maryland

WHIRLWIND II

The Whirlwind Computer

MANUFACTURER

Massachusetts Institute of Technology
Digital Computer Laboratory

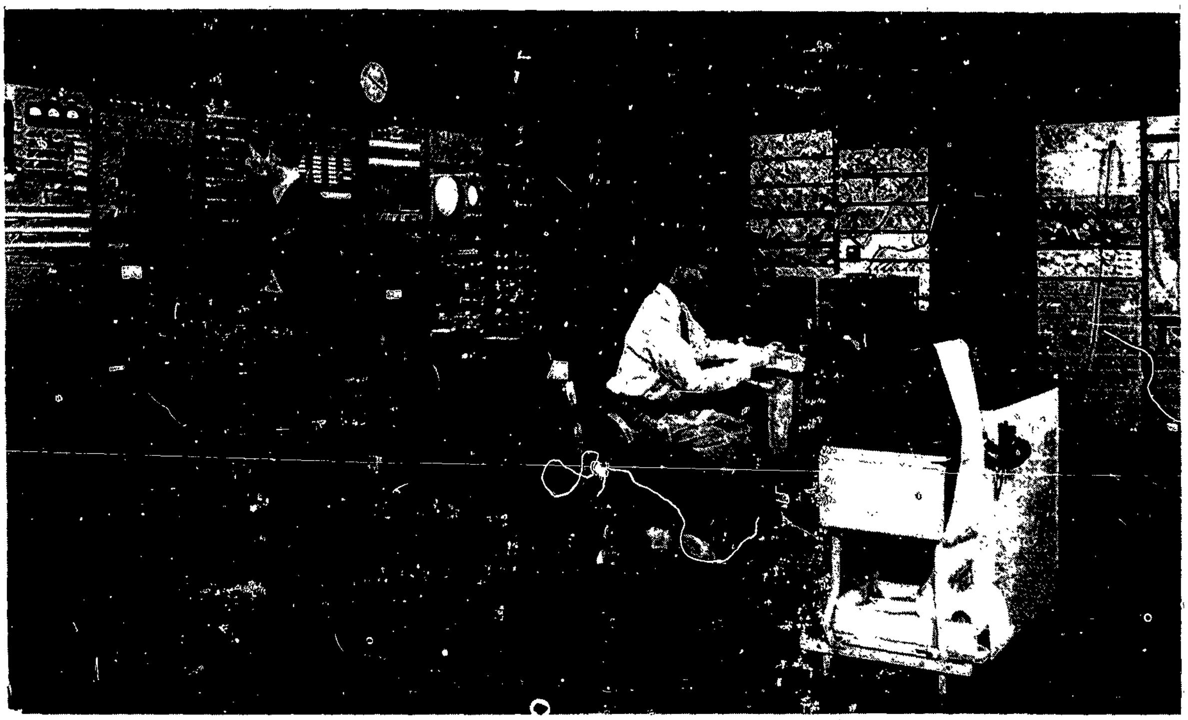


Photo by Massachusetts Institute of Technology

APPLICATIONS

Manufacturer

Scientific and engineering computation. The research reported in this computing system description was sponsored by the Office of Naval Research.

Air defense experiments leading to development of the SAGE System.

The Whirlwind I Computer was declared excess to the needs of the M.I.T. Lincoln Laboratory in the spring of 1959. Subsequently, the computer was leased by the Office of Naval Research to the Wolf Research and Development Corporation, Boston, Mass. The Wolf Research and Development Corporation then undertook the disconnecting and moving of the computer from the M.I.T. Barta Building. This move which commenced about 1 January 1960 was successfully completed by 1 May 1960. The computer is presently stored in a Navy warehouse and it is planned to move the machine and make it operational at a new site during early 1961.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	16
Binary digits/instruction	16
Instructions/word	1
Instructions decoded	32
Instructions used	29
Arithmetic system	Fixed point
Instruction type	One address
Number range	$2^{-15} - 1$ to $1 - 2^{-15}$

Instruction word format

Operation	Address
0 ... 4	5 ... 15

The basic operation code has been supplemented by a comprehensive system of service routines, providing for direct read-in of Flexowriter-coded perforated paper tapes, the logging of each problem on film and paper tape for subsequent processing, assembly during read-in of a suitable set of instructions including interpretive programmed-arithmetic (optional floating

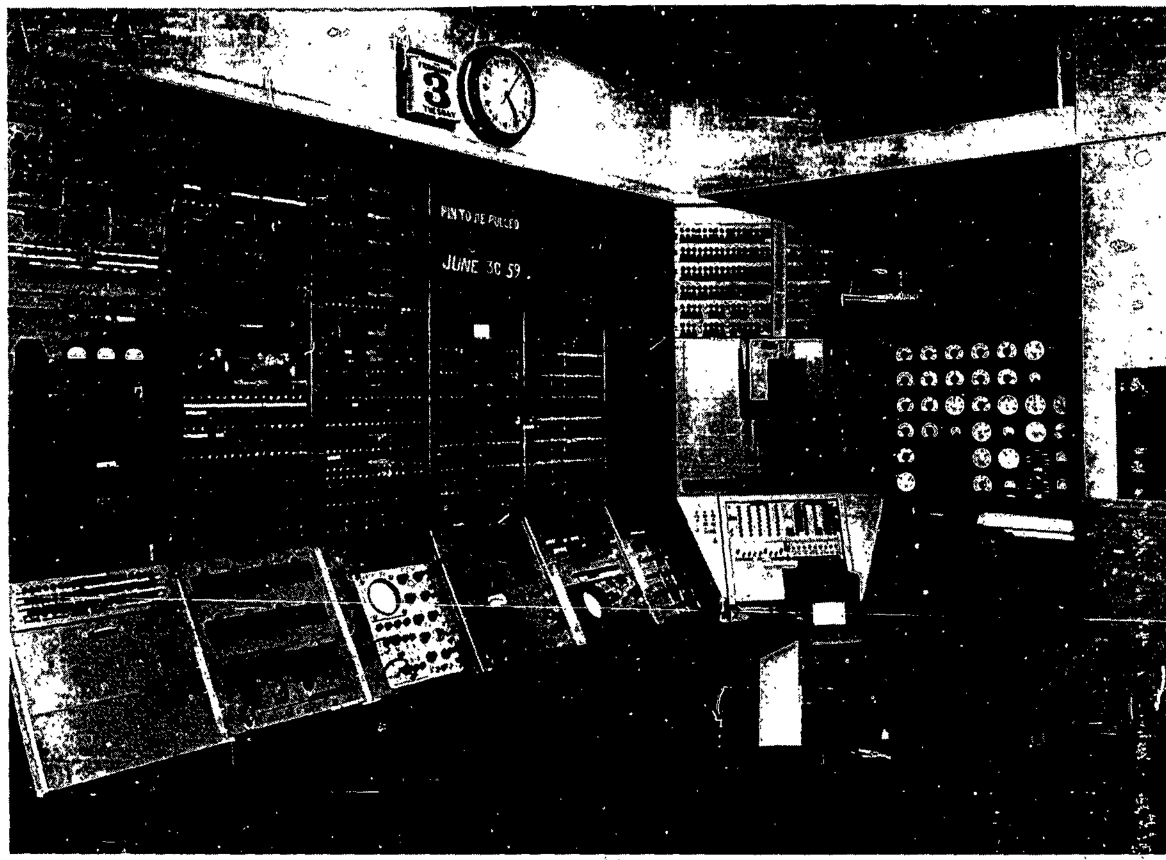


Photo by Wolf Research & Development Corporation

point), up to several hundred cycle counters (B-boxes), output routines, error detection, and automatic post mortems.

Routines are normally coded with mnemonic operations, symbolic addresses, relative addresses, program preset parameters, special psuedo-codes, and special control-words.

The service routines are stored on magnetic tape and are selected automatically during read-in.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	22	8
Mult	34-41	23.5
Div	71	57

Construction (Arithmetic unit only)

Type	Quantity
6145	517
7AK7	441
6SN7	96
3E29	14
6Y6	51

Basic pulse repetition rate	1 Megacycle/sec
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Media		Access Microsec
Magnetic Core	6,144	7
Two Magnetic Drums	36,848	8,300
Five Magnetic Tapes	125,000/tape	
Toggle Switch	32	1
Flip-flop	5	1

A word consists of 16 digits plus a parity digit. Read-rewrite time is 7 microseconds. Drum access time is average value.

Magnetic Tape

No. of units that can be connected	4 Units
No. of words/linear inch of tape	13 Words/inch
Channels or tracks on the tape	6 Tracks/tape
Blank tape separating each record	0.6 Inches
Tape speed	30 Inches/sec
Transfer rate	390 Words/sec
Start time	6.0 Millisec
Stop time	6.5 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	1/2 Inches
Length of reel	800 Feet
Composition	Acetate

Magnetic core storage consists of two banks of 1024 words each and one bank of 4096 words. These are divided into 6 fields of 1024 words, any two of which

may be used at a given time. A change fields instruction permits selection of the two fields to be used. A word consists of 16 digits plus a parity digit. Read-rewrite time is seven microseconds.

Magnetic drum storage consists of an auxiliary drum containing 12 groups each consisting of 2048 words plus six groups of 2048 words each contained on a buffer drum. The buffer drum contains four other groups which are used for input-output buffering of digital data.

A total of five magnetic tape units is available, of these a maximum of four may be connected to the computer at any one time and up to three may be connected to the associated delayed (off-line) printout system.

INPUT

Media	Speed
Paper Tape (Ferranti)	200 lines/sec
Paper Tape (Flexowriter)	14 lines/sec
Magnetic Tape	30 in/sec
Light Guns	Manual
Paper Tape (Teletype)	60 words/min
Switches	Manual
Digital Data Input	1,300 points/sec
Real Time Clock	60 pulses/sec

OUTPUT

Media	Speed
Magnetic Tape	188 char/sec
Oscilloscope-camera	200 char/sec
Paper Tape (Flexowriter)	10 char/sec
Oscilloscope-Camera	2 frames/sec
Oscilloscope-Display	6,000 points/sec
Printed Page (Flexowriter)	10 char/sec
Paper Tape (Teletype)	60 words/min
Printer (Teletype)	60 words/min
Digital Data Outputs	1,300 pulses/sec
Audible Alarm-Lights	4 words/sec

The oscilloscope displays vectors at the rate of 6,000 vectors/sec and characters at the rate of 3,000 char/sec. An IBM 523, modified, is used for reading and punching. Magnetic tape may be used for delayed Flexowriter output (off-line).

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	14,500
7AK7	6,145
6145	5,665
40 Types	
Diodes	14,000
Transistors	None
Magnetic Cores	104,448

Used in core memory only.

CHECKING FEATURES

Arithmetic element checks, parity checks of core memory and magnetic drums, and information transfer checks.

Marginal checking is done one hour daily to determine if any computer circuits have deteriorated during the past 24 hours.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	200 KVA
Power, air conditioner	150 KVA
Volume, computer	4,400 cu ft
Volume, input-output	2,100 cu ft
Volume, air conditioner	4,200 cu ft
Area, computer	450 sq ft
Area, input-output	210 sq ft
Area, air conditioner	525 sq ft
Room size, computer	30 ft x 70 ft
Room size, input-output	25 ft x 40 ft
Room size, air conditioner	30 ft x 50 ft
Floor loading	12 lbs/sq ft
	60 lbs concen max
Capacity, air conditioner	110 Tons
Weight, computer	37,000 lbs
Weight, air conditioner	16,000 lbs

PRODUCTION RECORD

Number produced to date 1

PERSONNEL REQUIREMENTS

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	1	1
Librarians	1	1	1
Operators	1	2	3
Engineers	1	1	1
Technicians	2	4	6
In-Output Oper	2	2	2
Tape Handlers	2	2	2

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	19.4 Hours
Good time	3,172.3 Hours
Attempted to run time	3,237.9 Hours
Operating ratio (Good/Attempted to run time)	0.98
Figures based on period 15 May 56 to 24 Sep 56	
Passed Customer Acceptance Test	1950

ADDITIONAL FEATURES AND REMARKS

Outstanding features are the display system including twenty-five 16" display scopes, 19 5" display scopes, 13 light guns, manual intervention switches and audible alarms. Digital data inputs and outputs via telephone lines, teletype input and output and real time clock.

INSTALLATIONS

Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

WISC
Wisconsin Integrally Synchronized Computer

MANUFACTURER
University of Wisconsin
Department of Electrical Engineering
Computing Laboratory

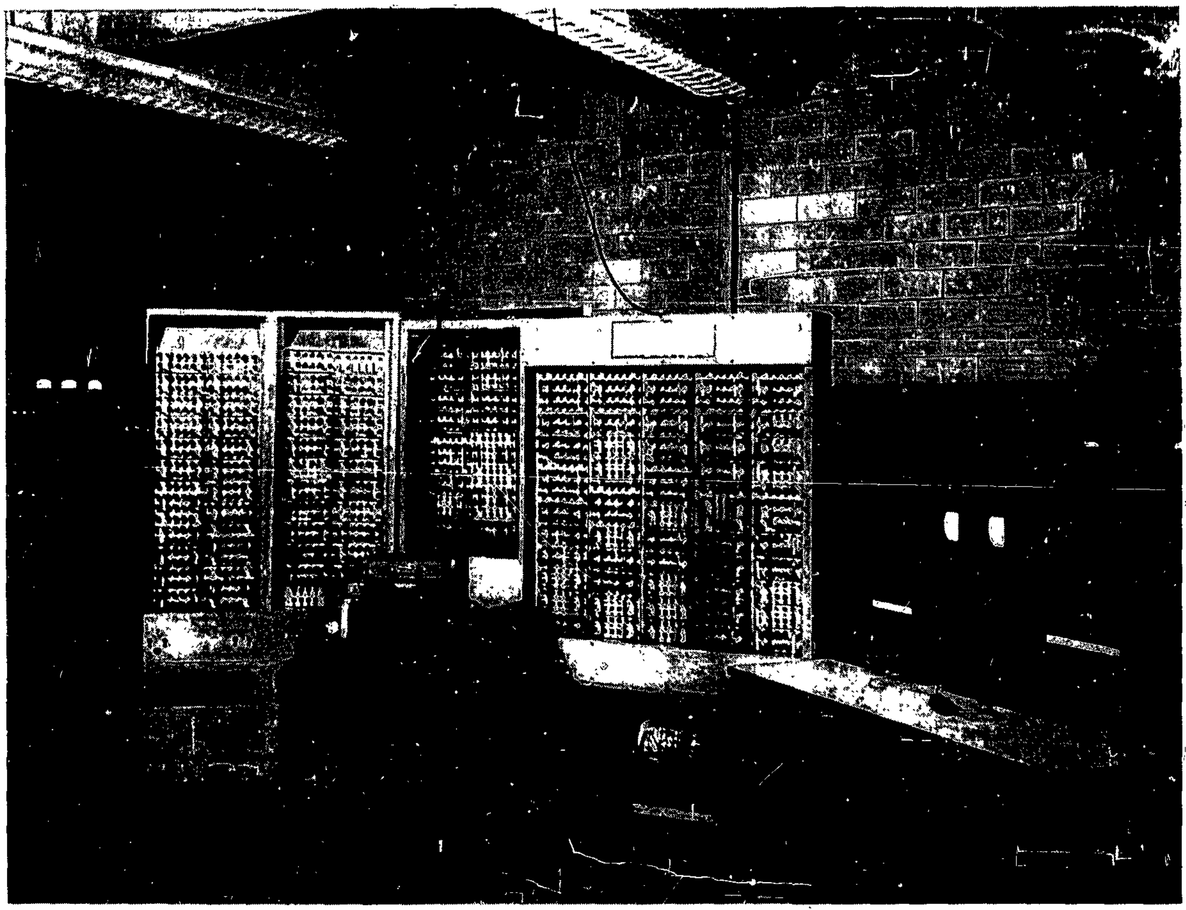


Photo by the University of Wisconsin

APPLICATIONS
General purpose scientific and engineering computation, engineering experimentation and training.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	50
Binary digits/instruction	50
Instructions /word	1
Instructions decoded	16
Instructions used	16
Arithmetic system	Floating point
Instruction type	Three address

Number range 40 binary digits times $2^{\pm 255}$

Instruction word format

10	4	12	12	12
X SPECIAL	T TYPE	A ADDRESS	B ADDRESS	C ADDRESS
50 - 41	40-37	36 - 25	24 - 13	12 - 1

1 bit (#49) used to select fixed point operation, breakpoint operation, etc.
6 bits (#41-46) used (along with 12 bits) to allow completely general Extract operation: Extract any number of bits from any stored word, shift right or left any number of places, insert into any other stored word.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec
Add	16,700
Mult	16,700
Div	16,700

Construction (Arithmetic unit only)

Type	Quantity
Tubes	
6211	400
5844	100
6AW8	4
6CM6	6
Diodes	
1N38	200

Rapid access word registers	7
Basic pulse repetition rate	100 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential Concurrent

Operations are carried out on four instructions simultaneously (Integral Synchronization) resulting in efficient use of access time. The four concurrent operations are read order N, locate two operands called for by order N-1, perform arithmetic of order N-2, and deliver result of order N-3. Floating point makes efficient use of otherwise long addition time.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	1,024	51,200	0 - 16,700
Magnetic Drum	4	550	
Magnetic Drum	3	440	

INPUT

Media	Speed
Punched Paper Tape	10 sexadec char/sec
Flexowriter Keyboard	Manual

OUTPUT

Media	Speed
Punched Paper Tape	10 sexadec char/sec
Flexowriter Typewriter	10 sexadec char/sec
Oscilloscope Monitor	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
5844	650
6211	650
6AQ5 - 6CM6	100
6AW8	14
6AG5	32
Diodes	
1N38	400
1N1128	3
1N1128R	3

6AQ6 being replaced by 6CM6

CHECKING FEATURES

Manually operated marginal checking voltages
Set of diagnostic routines

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	10.5 Kw
Power, air conditioner	7.5 Kw
Area, computer	40 sq ft
Area, air conditioner	15 sq ft
Capacity, air conditioner	7.5 Tons

PRODUCTION RECORD

Produced	1
Operating	1

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Engineers	1
Technicians	Students

ADDITIONAL FEATURES AND REMARKS

Extract instruction and floating point controls.
Remote control.

Digits in instructions corresponding to the sign of significant digits in numbers are not used in any instruction. Extract instruction is the only instruction which makes use of digits corresponding to exponent in numerical data.

System is financed by the Wisconsin Alumni Research Foundation and the University of Wisconsin, College of Engineering, Department of Electrical Engineering.

Design was governed largely by striving for simplicity of operation. Outstanding features include integral synchronization, general extract, fixed or floating point operation and a 50 bit word length.

FUTURE PLANS

Indirect addressing with automatic modification has been designed and a photoelectric reader and high speed punch have been acquired.

INSTALLATIONS

Computing Laboratory
Department of Electrical Engineering
College of Engineering
University of Wisconsin
Madison 6, Wisconsin

WRU SEARCHING SELECTOR

Western Reserve University Searching Selector

MANUFACTURER

Western Reserve University

Photo by Western Reserve University

APPLICATIONS

Located at 10831 Magnolia Road, Cleveland 6, Ohio, the system is used for the scanning of encoded abstracts of scientific publications for literature searching purposes. Applied to literature projects of American Society for Metals, American Diabetes Association, and Communicable Disease Center (Atlanta, Ga.).

STORAGE

Media
Paper Tape Library
Relays

The paper tape library is scanned at Flexowriter speeds.

INPUT

Medium	Speed
Paper Tape	10 char/sec

OUTPUT

Medium	Speed
Typed Page	10 char/sec
Paper Tape	10 char/sec

PERSONNEL REQUIREMENTS

	One 8-Hour Shift		Two 8-Hour Shifts	
	Used	Recomm	Used	Recomm
Analysts	1	1	1	1
Programmers	1	1	1	1
Operators	1	1	2	2

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

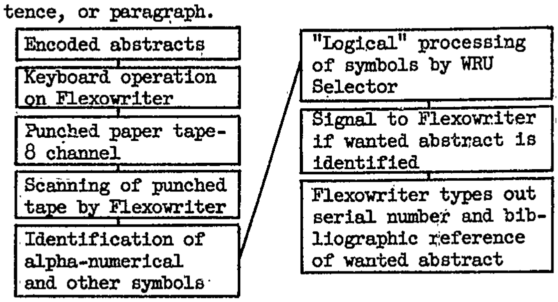
Good time 60 Hours/Week (Average)
Attempted to run time 70 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.86
Above figures based on period 1 Jan 60 to 1 May 60
Time is available for rent to qualified outside organizations.

ADDITIONAL FEATURES AND REMARKS

The starting point for designing this equipment was the realization that documentation systems are called upon to meet a wide variety of information requirements. These range from narrowly defined specific inquiries to comprehensive correlations. More detailed analysis revealed that any given requirement almost without exception involves a combination of several concepts. Both subject indexing, as ordinarily practiced, and the pigeon-hole type of classification systems make use of preestablished concept combinations insofar as such combinations are used at all. Hand-sorted punched cards and various mechanized systems have demonstrated during the past ten years that highly advantageous benefits may be realized by defining searching and selecting operations in terms of concept combinations not established or anticipated at the time of analyzing the subject contents of documents.

The Western Reserve Searching Selector permits an exceptionally wide range of concepts to be used in defining and conducting searching operations. Thus, the scope of a search may be defined not only in terms of specific substances, devices, attributes, processes, conditions, organisms, persons, locations, etc., but also in terms of generic concepts and their relationships to specific terms. Furthermore, observational relationships, for example the roles in a given experiment or situation of various substances, devices, etc, taken either specifically or generically, may also be designed as points of reference in defining searches.

This wide range of possibilities is accomplished by the ability of the Western Reserve Searching Selector to detect combinations of symbols and combinations of combinations at a multiplicity of levels. At each level, combinations may be defined in terms of logical product, logical sum, logical difference or derived complex logical relationships. The different combinational levels may be thought of as analogous to the combining of letters to construct sentences, sentences to construct paragraphs, etc. The machine is able automatically to detect the start and end of each organized symbolic unit analogous to word, phase, sentence, or paragraph.



Selector Operations

This use of analogy, though illuminating, must not be regarded as definitive. Actually, to avoid the complexity of phrasing and sentence structure encountered in natural language, well-defined rules for indicating relationship of a syntactical nature have been worked out. Application of these rules results in the expressing of the subject content of a given document in the form of a telegraphic-style abstract with syntactical relationships rendered explicit by carefully defined role indicator. Encoding the terminology in such abstracts explicitly indicates the relationship of each term to concepts of generic scope.

Prior to conducting a search, an information requirement is analyzed in terms of appropriate specific and generic terms, role indicators and logically defined relationships between them. The information requirement is thus analyzed on the same basis as is used to record the information contents of documents in the form of encoded abstracts. The searching step as performed by the Searching Selector consists of a series of logically defined matching operations involving the common set of terms used for analyzing the information requirement and the information contents of documents.

The Searching Selector has been designed so that ten searches may be conducted simultaneously. Such searches may be interrelated as to scope or completely independent.

FUTURE PLANS

The system has been replaced during 1960 with the GE 250 computing system.

INSTALLATIONS

Center for Documentation and Communication Research
Western Research University
Cleveland 6, Ohio

CHAPTER III

ANALYSIS AND TRENDS

ANALYSIS AND TRENDS

INTRODUCTION

The information for each of the 222 systems described in Chapter II has been subdivided into eighteen topics, permitting the data to be presented in an organized manner and simplifying the comparison of features of the different systems. The following paragraphs, paralleling the subdivisions of the systems descriptions of Chapter II, are an attempt to quantitatively analyze the data and show recent trends in the field of computing machinery. It is emphasized again that the information given in Tables II through XV in this Chapter is to be used with caution. The tables have been constructed only to show trends, permit limited comparison of systems and show the present state of the art. Information pertaining to a specific system should be obtained from the system description in Chapter II or directly from manufacturers and users.

DESIGNATION OF COMPUTING SYSTEMS

The names of various types of computing systems existing in the United States stem from different sources. It would have been convenient if some system of classification and standard nomenclature had been established many years ago. The nomenclature could have incorporated the name of the manufacturer and model number, the nature or application of the system, or the name or location of the operating agency. However, a system of nomenclature was not established, resulting in an odd mixture of names for computing systems. Many computing systems bear the name of the manufacturing organization, for example IBM 704, HONEYWELL 800, NATIONAL 304, ILLIAC, and RCA 501. The names of some machines indicate the nature or purpose of the system, for example WESTINGHOUSE AIRBORNE, VOTE TALLY SYSTEM, CUBIC AIR TRAFFIC, WHIRLWIND and EDVAC. Other machine titles indicate the name of the operating agency, such as DYSEAC, SEAC, NORC, OARAC, ORACLE and ORDVAC. Some titles are indicative of the location of the system, such as LARC. The names of some machines are trade names like UNIVAC II and ELECOM 125. There are some machines named after specific persons, as are ALWAC III E and JOHNNIAC. Arbitrary names, like GEORGE, also exist. Another trend in computing machine nomenclature has been to develop names which were contractions or pronouncable abbreviations of significant titles. Examples of this are EDVAC, for <u>E</u>lectronic <u>D</u>iscrete <u>V</u>ariable <u>A</u>utomatic <u>C</u>omputer; MANIAC, for <u>M</u>athematical <u>A</u>nalyzer and <u>N</u>umerical <u>I</u>ntegrator <u>A</u>nd <u>C</u>omputer; and ORDVAC, for <u>ORD</u>nance <u>V</u>ariable <u>A</u>utomatic <u>C</u>omputer.

MANUFACTURERS OF COMPUTING SYSTEMS

In the interest of national defense, the development of electronic computing systems could not wait until normal economic laws brought about the supply of systems through commercial demand. The Department of Defense supported research and development in the field of electronic digital computers to be utilized for rapid scientific computation on defense projects.

The world's first electronic digital computer, the ENIAC, designed and developed by the Moore School of Electrical Engineering of the University of Pennsylvania, for the Ballistic Research Laboratories was placed in operation at the Aberdeen Proving Ground in January 1947. Many early electronic machines were manufactured at educational institutions such as the Institute for Advanced Study, MIT, Harvard and the Universities of Pennsylvania and California. Parallel research was performed by industry, and by 1950, large scale digital electronic computers were being delivered commercially. At the present time mass production of large scale systems is well underway. Several thousand large scale systems of various types have been mass produced, and thousands are on order. Table I shows the manufacturers of all the machines described in Chapter II and Table II shows the approximate quantities of these systems which have been produced.

APPLICATIONS OF COMPUTING SYSTEMS

The installation of the ENIAC, at the Ballistic Research Laboratories of the U. S. Army Ordnance Corps marked the beginning of the widespread use of electronic computing machines. Since the advent of the ENIAC, a large expansion has taken place in the computer field. Investment rates in computing equipment in the United States have risen from ten million dollars per year in 1953 to one hundred million dollars per year in 1956. Present expenditures for computing equipment has passed the billion dollars per year mark.

Almost every commodity industry such as oil, steel and rubber is utilizing computing equipment for both scientific and commercial applications. Service industries, such as banking, transportation, and insurance have applied large scale systems toward the solution of problems in the fields of accounting, reservations control, and bookkeeping. Manufacturers have used computing systems for design engineering and scientific research. Many systems are being utilized for inventory and stock control. The determination of manufacturing plant location and stock parts storage are being made by linear programming methods. Electronic computers are being utilized by the construction industry for design and location of structures and road nets. Many digital computers form a part of closed loop industrial process control systems.

Many problems require the processing of large quantities of data, such as is obtained from missile tracking, telemetering, mineral deposit prospecting and record keeping. The use of electronic computing equipment permits the processing of large quantities of such data over relatively short periods of time.

Many "on-line" applications of both general and special purpose computers are being made. These control applications include such examples as control of wind tunnel testing and continuous-flow manufacturing. Computers are being used for aircraft and missile fire and flight control, both as ground based and missile borne systems.

A discussion of applications of specific systems will be found under the sub-heading "APPLICATIONS" in the various computing systems descriptions given in Chapter II.

PROGRAMMING AND NUMERICAL SYSTEM

Internal Number System

Many types of number systems have been utilized for the development of logical designs of computing systems. Among these number systems are the straight binary, octal, binary coded decimal, straight decimal, sexadecimal, biquinary, binary coded alphanumeric, and binary coded decimal (excess three). Of 187 different relevant systems, 131 utilize a straight binary system internally, whereas 53 utilize the decimal system (primarily binary coded decimal) and 3 systems utilize a binary coded alphanumeric system of notation. Of course, in nearly every computing system, information is ultimately handled in binary form, particularly in storage and in arithmetic units. The primary method of storage exploits the inherent properties of material media, such as semiconductors, and ferroelectric and ferromagnetic materials. The state of conduction or the polarization of ferroelectric and ferromagnetic materials determine the nature of the information which is stored or being processed. Decimal digits are handled as groups of four bits, or tetrads. Alphanumeric data usually requires the use of six bits, permitting 64 different symbols. Some systems utilize seven bits for expressing a single character, permitting 128 different characters, or may utilize a single bit as an "odd-even" check bit. Programmers and coders preparing problems for solution on these systems may work with decimal or alphanumeric notation and need not be concerned with the binary coding performed automatically by the machine.

Word Length

The selection of word length for computing systems is based upon many considerations. For information words, the precision required for the solution of problems may be the major consideration. For instruction words, word space must be allocated to the address of the operand (or operands for multi-

address codes), the command, and perhaps spares, tags, or check digits. For example, the ORDVAC utilizes 39 bits plus sign for an information word. One-half of a word, or 20 bits, is subdivided into a 12-bit address portion (for 4,096 high speed storage locations), a 6 bit command portion for 64 commands, and a 2-bit spare digit portion for special applications and versatility. The variation of word length among existing systems is rather wide. Table III shows the word lengths of the 222 systems described in Chapter II, in ascending order of magnitude. The average or nominal word length for fixed word length machines is approximately 40 binary or 12 decimal digits.

Number of Instructions Per Word

In many systems the machine word structure permits several instructions to be expressed by a single word. Of 171 systems, 107 were reported as operating on a one instruction per word basis and 23 were reported as operating on a two instructions per word basis. Several systems required two words to express a complete instruction and, in some systems, several instructions could be expressed by a single word, at the option of the programmer.

Arithmetic System

Most of the earlier machines operated on a fixed point arithmetic system. The binary or decimal point was arbitrarily fixed at either the right or left end of the number. For some systems a centered decimal point permitted the direct expression of whole and fractional parts of numbers. Scaling is required, for example, when a decimal or binary point is located at the left end of a number, in which case all quantities must be scaled between the values of minus one and plus one.

Many of the later machines were manufactured with built-in automatic floating point equipment, permitting numbers to be expressed as fractional parts and exponent parts. The exponent usually is a power of two or ten. Floating point circuitry was added to many of the older systems. A review of this sub-heading in the systems descriptions found in Chapter II and an examination of Table III will show the distribution of fixed and floating point equipment.

Instruction Type

Internally programmed automatic computers require that part of the instruction word be devoted to the address (or addresses) of the operand (or operands). The question of how many addresses are to be incorporated into a single word has been answered in many ways. In single address machines, the address of one operand is given in the address portion of the instruction word. In two address machines, the address of two operands are given, for instance the addresses of the minuend and subtrahend are given for a subtract instruction. For three address machines, the address for storing the result, e.g., the sum, difference, product, quotient or square-root, is given. The three address machines usually refer automatically to the next storage location, in sequence, for the next three-address instruction word. Machines using the four-address instruction will express the location of two operands, the location for storing the results of the operation, and the location of the next instruction, all in one four-address word. In a 1 + 1 system of notation the address of an operand for the current instruction is given, along with the address of the next instruction to be performed. Coding for four-address machines is somewhat simplified, however, a more complex machine structure is necessary. The following table shows the distribution of different addressing systems among the types of computers described in the handbook.

Instruction Type	Different Systems Using Given Type Instruction
One-address	116
Two-address	23
One or two-address (optional)	13
Three-address	20
Four-address	7
One-plus-one and one-over-one address	8
One and one-half address	3
One or three-address (optional)	2

One or one-plus-one address (optional)	2
One, two, or three-address (optional)	2
One, two, or four-address (optional)	1
Modified three-address	1
Three or four-address (optional)	1
Variable up to five-address (optional)	1
Total	200

Instruction Word Format

Most systems require adherence to a specific format or sets of formats for preparing coded instructions, in the machine language. The instruction word format thus outlines the form in which the instruction is prepared. An accounting must be made of each digit or character of the instruction word.

ARITHMETIC UNITS

Operation Time

Since the primary function of an arithmetic unit in any computer is to perform repetitive arithmetic operations rapidly, the time required to execute an add instruction or a given sequence of arithmetic or logical instructions, is extremely important when selecting a computing system for a specific application. Tables IV and V were prepared to show at a glance the general state of the art with respect to arithmetic speeds. It must be emphasized that the values stated in the table are on an "as reported basis". The reader is reminded that the tables must be used with caution, since many clarifying or related remarks have been omitted for the sake of simplicity. Refer to the system descriptions of Chapter II for further detail.

Table IV shows the approximate relative order of add time when including the storage access time. In many systems, it is not possible to determine the time required for one addition without considering storage access. This may be due to the fact that in many types of operation, sums may form in an accumulator as the addend is brought from storage, hence access time may be inseparable from add time.

Construction of Arithmetic Units

Most of the computing systems described in this report utilize tubes or transistors as the basic driving element in the arithmetic unit. Several systems utilize magnetic cores in the arithmetic unit. Gating for arithmetic and logical units is most usually performed by diodes, transistors, or vacuum tubes. A review of the construction methods used in arithmetic units is discussed under this topic in the systems descriptions.

STORAGE

An extremely diverse and dynamic field of interest in the study of computing systems is the subject of storage devices. Many ingenious devices, utilizing the ability of various material media to store or record energy transformations, have been devised. Early forms of storage involved mechanical deformation of material media. These are exemplified by cams, springs, gears, music box cylinders, perforated player piano rolls, code wheels and perforated paper tape. All these storage devices required the movement of large masses of material and consequently long access time was inherent. The capacity, in terms of stored information per unit volume of material, was very low.

During World War II, the search for more rapid access storage devices led to the use of the vacuum tube. The two states, that of conduction and that of cut-off, permit information storage on a binary basis. This system, as was used on the ENIAC, proved effective from an access time consideration, however, the system was extremely bulky and required thousands of electronic vacuum tubes for a storage unit consisting of only 20 words of 10 decimal digits each.

Chronologically, the next development was the use of acoustic delay lines of mercury and quartz. A transducer at each end of a length of these materials permits energy conversions and allows the storage of information in the form of high frequency (e.g. 8 megacycles/sec) pulse packets. The information is

continuously recirculated. Information is inserted or read out through the use of standard gating techniques. Among the computers utilizing acoustic mercury delay lines are the DYSEAC, EDVAC, ELECOM 125, SEAC and UNIVAC I. Quartz acoustic delay lines were also used. Other types of delay lines used for storage of information are the magnetostrictive and the electromagnetic or distributed L-C network. See Tables VI, VII and VIII, which list the computing systems utilizing delay line storage units. Although in operating principle there is no difference, it is necessary to make a distinction between a delay line used in a storage loop in which information is continuously circulated, and a delay line used only for purposes of timing the arrival of information at selected points for performing various logical operations. In the latter, the function is delay, or temporary storage, rather than permanent storage. Since delay lines store information serially as a train of electrical or sonic pulses, average random access time is limited to half of the time length of the delay line plus the time equivalent to one word length. Because of the serial nature of the system, delay line storage units are limited in speed. Notice how the delay line types of systems lie near the bottom of the Access Time of High Speed Storage, Table VI.

The search for shorter access time brought about the development of the electrostatic storage unit, also called the cathode ray tube storage device. The material medium in motion was now limited to electrons, i.e., in beams and on charged areas on the screen of a cathode ray tube. These charged areas behaved somewhat like an array of charged capacitors. Selection of storage locations and the transfer of information was efficiently performed by an easily deflected pencil or beam of electrons which was used for both writing and interrogation. Parallel transfer, in which all digits of a given word are transferred simultaneously, became possible with this type of storage system.

The electrostatic storage system, with the inherent problems associated with high accelerating voltages, screen imperfections and other tube failures, has all but yielded to the utilization of magnetic cores for the storage of information. A 32 x 32 array of ferrite cores, which might constitute a typical storage plane, may measure only a few inches on each side. The cores are placed at the intersection of the wires of a mesh, and a third winding may be threaded through all the cores for sensing stored data. The storage takes place in the form of magnetically oriented molecular or atomic dipoles which retain their orientation upon removal of the magnetizing force. Many manufacturers intend to provide computing systems with large capacity core storage units. Advances have been made in the use of perforated ferrite plates and magnetic films deposited on glass as a magnetic storage unit. Two such systems, the LINCOLN TX 2 and the UNIVAC 1107 utilize thin films. The storage principle is the same as for magnetic cores. Table VI shows the access time of high speed storage units in their approximate relative order of magnitude for the storage units used in various computing systems. It must be emphasized that the question of precisely what constitutes access time cannot easily be resolved unless a common understanding as to the definition is reached. In the usual sense, one may consider access time as the elapsed time between the initiation of a command to transfer an item of information, usually one word, from one address in the storage to another designated register, and the complete arrival of the item at the designated location. In many systems, particularly serial storage units, access time depends upon the time location of the word in the serially circulating group of words at the instant the transfer command is initiated. For this and other reasons, much misunderstanding can arise in the consideration of access time. the data presented in Table VI should therefore be considered to be approximate and should be used with caution.

The capacity of high speed storage units has risen during the past few years as rapidly as access time has diminished. Table VII shows the capacity of high speed storage units in terms of numbers of words and word lengths, arranged in relative order of magnitude of equivalent binary capacity.

Rapid access storage of limited capacity is usually supported by a larger capacity storage unit for a well balanced storage system. This permits the transfer of large blocks of information from the rapid access storage unit to the large capacity storage unit for use at another location or time in the

computation process. The most prevalent devices for auxiliary storage of this type are the magnetic drum or the magnetic disc. The access time for large blocks of information is of the order of tens of milliseconds for most magnetic drum or disc units. Many computing systems utilize magnetic drums or discs as the primary storage unit. Several systems utilize large capacity drum or disc units particularly for commercial type applications, such as payroll, stock inventory, and personnel records where access times of the order of microseconds are not required. Table IX shows the capacity of various drum or disc storage systems currently in use. It should be remembered, when glancing at Table IX, that although an attempt was made to show maximum capability, additional drum or disc units can be attached to some systems. Many systems employ magnetic tape as a medium of storage. Although access time is relatively long because of its inherently serial nature, a large volume of data can be stored on tape with a high packing density in terms of data units per unit volume.

The characteristics of a storage device, namely, capacity and access time are two aspects of a storage system which come under consideration when designing or using a machine. The user or manufacturer of a system, at times, can trade capacity for access in the sense that under certain conditions he can accomplish an equivalent amount of computation with a large capacity, somewhat longer access time system as with a small capacity, short access time system. This is the old problem of trading time for space or vice versa. There are limits to this however, for example, when access time approaches the order of milliseconds, computation is seriously slowed down. Since large capacity and short access time are features to be desired, let us examine a quantity determined by the expression:

$$\mathrm{Log}_{10}\ (\text{Capacity in Equivalent Binary Digits/Access Time in Seconds})$$

In early storage devices, such as music boxes and signal coding equipment, this number is of the order of two to three. Relay storage units have a number of the order of four or five. Tube registers of the ENIAC vacuum tube accumulator storage type, enabled this figure to be as high as 6.3. Magnetic drum storage units are in the region of 6 to 7. Acoustic delay line storage systems show that this figure is in the range 8.6 to 9.6. The cathode ray tube storage (electrostatic) raised the figure as high as 10.79. The magnetic core storage unit permitted an increase of this figure to over 12. Thin films have now arrived on the scene as a practical storage medium. The following table shows the growth, or increase of this number, as development of computing system components progressed:

Storage Device	Approx. Median Log_{10} Capacity/Access	Approximate Year of Development
Early Mechanical	2 - 3	Prior to 1930
Electromechanical	4 - 5	1935
Vacuum Tube	5 - 6	1940
Magnetic Drum	6 - 7	1945
Electrostatic (CRT)	9 - 10	1950
Static Magnetic (Mag. Core)	9 - 12	1955
Thin Film	10 - ?	1960

Table VIII is a tabulation of the Log_{10} Capacity/Access figures for the high speed storage units of various computing systems in approximate relative order of magnitude.

INPUT-OUTPUT

The above discussion on arithmetic units and storage devices have shown the great strides that have been made in these fields during the past several years. Arithmetic operation and storage access times have decreased and storage capacity increased. Yet, the communication link between the person and the machine still presents a major problem. Paper tape and cards, inherently bulky, are prevalent and relatively slow, particularly for scientific applications. The main convenience afforded by cards, particularly in commercial systems, is their capability of storing a complete item of information on one card, which may be handled separately or as part of a group, such as data on an insurance policy, a

payroll line, a stock item, a set of corresponding test data, etc. There is no doubt that punching cards is a slow process. Paper tape perforators are also relatively slow in the sense that the data to be punched is usually available at a rate faster than paper may be mechanically perforated, although high speed perforators are being developed and are finding application. Keyboard input systems are useful primarily for the manual insertion of words for test or other special purposes.

In addition to paper tape and card readers and punches, many systems utilize high speed printers and magnetic tape units as a medium of input and output. Magnetic tape output still requires a conversion from magnetic tape to cards or printed page in order that the information be available to operating personnel. However, since human intervention is gradually being reduced, the use of magnetic tape for input, output and storage is increasing rapidly. The prevalence of various input-output media for the 222 computing systems described in this report may be determined by examining the data under the sub-heading "INPUT" and "OUTPUT" in the systems descriptions given in Chapter II.

One method for decreasing machine time spent waiting for reading and writing instructions to be carried out is to provide for concurrent operation. The later machines have built-in circuitry for permitting reading and writing to take place during computations. Apparently the only stipulation is that a given storage location does not become involved in reading, writing and computing at the same time. Many machines, for example, compute while punching and reading cards or while "looking-up" information on tape. Others fetch the next instruction out of storage while performing an operation.

Another method of reducing reading and writing time and to avoid a large amount of lost time when a large amount of machine reading and writing is necessary is to provide for reading and writing on a high speed device such as a magnetic tape or wire unit and allow "conversion" to another medium to take place off the machine at "leisure". Magnetic tape-to-card converters and inverters are becoming available as well as magnetic tape-to-printed-page converters. Paper tape and cards may sometimes be considered as forms of storage, since information recorded on these media may be returned to the machine. Considerable progress is being made in the field of printed page readers. See, for example, the IBM 1401 System.

It is often necessary to have computing systems capable of communicating with one another directly. For this reason, input-output media conversion is becoming quite prevalent and large conversion equipment is rapidly becoming available. Input-output schemes are so many and varied, that a complete treatment of this subject is beyond the scope of this report.

CIRCUIT ELEMENTS OF THE ENTIRE SYSTEM

There are many impressions which come to mind when one examines such things as transistor, tube and crystal diode counts in a large scale computing system. There is a tendency to visualize a large, sprawling system when the tube count is high. There may be large tube-changing programs based on experience in effect on these large systems. Failure rates, preventive maintenance techniques, tube life problems, design limitations and tube specifications must all be considered on a systematic basis when the tube count is high. Tube count and a knowledge of tube operating characteristics may yield an approximate estimation of some of the problems that may be encountered in the operation of the system. Table X shows the approximate number of tubes utilized in some of the computing systems described in this report. Maintenance of transistorized systems has become somewhat simpler than maintenance of vacuum tube systems. Power and space requirements for transistorized systems are considerably reduced.

The servicing of a large electronic computing system can be materially simplified by reducing the number of tube types in the system. Standards for tube testing need apply to fewer tube types and tube checking can be further systematized due to a reduced number of test variations. Of course, a test specification or test criterion must be established for the most severe application for which the particular tube type will be applied. A severe or special circuit requirement may be better served through

the use of another tube type. This, then increases the number of tube types. Normally, it is possible to select a type of tube for a group of duties. In a given system, for example, a certain type is selected for driving, for voltage amplification, for flip-flop circuits, normally "on" or "off" conditions, etc. This establishes a number of tube types for a given system and any modification of the system usually should include this "tube type" complement.

The question of crystal diode reliability, diode testing techniques, and diode logical network design, such as individual clamps versus wired plug-in units, become subjects of interest when diodes are utilized. The quantity of diodes in a given computing system may be indicative of the nature of the servicing problem, but only when the failure rates, life and circuit demands placed upon the diode are known. To some extent, malfunctions due to diodes can be aggravated by elevated temperatures. The printed circuit logical package, containing a specific array of "And" and "Or" gates have become the most prevalent means of fabrication. The extent of crystal diode use is shown in Table XI.

Many recently developed systems utilize transistors for driving, switching (gating) and other logical functions. Reduced power and reduced space requirements are advantages of these systems. The question of reliability is rapidly being resolved, as printed circuits and packaging techniques continue to be improved. Table XII shows the quantity of transistors utilized in the various computing systems described in Chapter II.

CHECKING FEATURES

The question of what type of checking features should be incorporated into a given general purpose computing system is still being tossed about by various manufacturers. The type of built-in check varies from manufacturer to manufacturer and from system to system.

It is usually possible to check all machine calculations by programming techniques. A well designed system can proceed for many hours without a malfunction. If this is the case, it is entirely possible that the installation of a checking system can do more harm than good since the checking features can malfunction and cause an alarm or stoppage when a machine malfunction has not occurred. For example, the second unit of twin arithmetic units can malfunction, the comparer of a redundancy checker can malfunction, or a forbidden pulse combination decoder can malfunction, all yielding false indications of a machine malfunction. For those systems which do not have built-in checking circuits, the operator or programmer must program a check or the output may be reviewed.

About 87% of the 222 computing systems reported utilize some form of automatic built-in check. A redundancy or duplication check is used in about 8% of the systems. Some type of overflow or exceed capacity is used on about 23% of the systems and an odd-even parity check in one form or another is used on 50% of the systems. Interesting to note here is that in 1957 only 20% of the systems had a form of parity check. Various kinds of transfer checks are used on 19% of the systems. Approximately 28% of the systems established a checking system by detecting pulse combinations which are not supposed to occur anywhere in the system. Forbidden pulse combinations checking stations are scattered around the system, e.g. in memory transfer points, recording stations, reading stations, etc. The various names that have been applied to this type of check are forbidden pulse combination, unused order (instruction), unallowable order digit, improper operation code, improper command, false code, forbidden digit, non-existent code, and unused code. There is a distinction to be made between the terms order, instruction, and command. The preferred definitions are given in the glossary of computer engineering and programming terminology, Chapter IV. The following table shows the approximate distribution of checking methods in the systems described in this report. Many systems utilize more than one check technique.

Distribution of Automatic Checking Schemes Among 222 Different Computing Systems

Parity (arithmetic, transfer, storage, recording)	99
Overflow (underflow, exceed capacity, divide by zero, divide overflow, oversized quotient)	47
Transfer (echo, compare, validity)	38
Non-existent command	19
Non-existent memory address	15
Redundancy (equipment, operations)	15
Character code (non-numeric, illegitimate char, "all ones", sign)	14
Forbidden pulse combination (general)	14
Arithmetic (Modulo 3, 4, 9, 25, residue)	13
Timing (clock, synchronism, jitter)	12
Count (hole, address, row, block, word, random error)	9
Non-existent device	8
Miscellaneous (instruction-data, logic, inactivity, unwanted digit, free time)	7
No built-in check	26
Not reported	22

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Important aspects of computing systems are the physical factors of power, space and weight.

Power requirements may very well dictate the physical location of a large computing system within a building, particularly when the power required is in excess of 50 Kw. For most systems, however, the power is brought to the most favorable computer location from the point of view of personnel [illegible]cessibility for operation and servicing. Table XIII shows the power requirement of vari[illegible] dom[illegible] computing systems, operational or about to become operational in the United Stat[illegible]

An interesting figure might be the relation between the numb[illegible] a c[illegible]ing system and the power requirement. In order to determine whether o[illegible] not a [illegible]nt tube to power ra[illegible] could be established, the ratio was determined for the computing system[illegible] for which the data [illegible] av[illegible]able. For the vast majority of computing systems the tube-power ratio is appr[illegible]ximat[illegible] [illegible]lo-watt. A sample taken of transistorized systems [illegible] the ratio of [illegible] quantity to power is about 6,000 transistors/kilowatt.

The problem of space requirements has been solved in so many ways it is impossible to determine a consistent relation between space requirement and any other factor. Large computing complexes have been installed in areas ranging from a corner of a basement to an entire floor of a large building. The pictorial coverage of computing systems and the space requirements discussed under the sub-heading "POWER, SPACE, WEIGHT, AND SITE PREPARATION" in the systems descriptions of Chapter II give the space requirements of the computing systems described in this report. The dimensions of various components of utilized systems are important when considering clearance in rooms, passages, doorways and elevators.

Air conditioning requirements vary considerably from system to system. Air conditioners for computing equipment may utilize water to absorb the heat from circulated air, use a secondary loop of air, force the heated air to the outside, or utilize an outdoor evaporator. The smaller systems circulate room air and depend on the ambient temperature to cool. Almost 100% of the power required by the system is dissipated in the form of heat and must be removed. The large systems usually require separate heat removal facilities. For many systems, humidity and dust control within the machine are required in order to maintain satisfactory operation.

The factor of weight can be important when the floor loading limits for distributed and concentrated loads are within the weight range of the computing equipment. Many systems may require reinforced or specially constructed buildings. Many items of peripheral equipment may cause concentrated loads in

excess of maximum permissable concentrated loadings on some structures. Vibration and shock caused by some equipment such as tabulators and card punches can cause trouble in other components. Shock and vibration absorbing pads are required in such cases. When unitized construction is used, the weight of a single unit must also be considered when transporting and installing.

Many systems require extensive site preparations. Others may be "plugged in" to any convenient outlet. This topic is adequately discussed in the systems descriptions of Chapter II.

PRODUCTION RECORD

In almost any new and rapidly changing field there will be many instances in which an experimental prototype of a large piece of equipment will be built. This is the result of the normal course of events, namely, a feasibility study, a research effort, a development effort and a prototype construction. Mass production then occurs when the demand for systems is sufficient to warrant production in quantity.

A review of the sub-heading "PRODUCTION RECORD" will give an indication of the production status of various computing systems. The quantity produced, the quantity in current production, in current operation, and on order are given. Delivery times quoted show that immediate delivery is now possible for many computing systems. Table II shows the quantities of the various systems that have been produced. Information on unreported systems was considered proprietary by the manufacturer.

COST, PRICE AND RENTAL RATE

Perhaps the most elusive and intricate item considered in the systems descriptions of this report is the question of initial cost, blandly described as "approximate cost of basic system". Manufacturers are quite naturally quoting current prices for their respective systems. The "one of a kind" system usually includes all research, development, construction, overhead and sub-contracting costs. The "basic system" usually includes minimal input devices, the controls, the storage system, the arithmetic unit, and minimal output devices. All conversion equipment such as card-to-printed page (tabulators), card-to-tape, tape-to-card etc. are considered peripheral equipment, and both the quantity and type is dependent upon specific system application. These are not included in the cost or price of the basic system. Prices of these may be found under "Additional Equipment". In order to determine the cost of a given system, refer to the system description. Table XIV shows the approximate relative cost of various computing systems. No attempt was made to resolve or explain any discrepancies between prices quoted by manufacturers and those quoted by users. It should be remembered that users prices reflect old sales, rental rates were established by contracts written years ago, manufacturers are offering discounts on older systems, charging greater service rates for older systems, offering educational discounts, etc.

The methods of computing system or component acquisition include direct purchase at a fixed price, direct purchase on a cost plus fixed fee basis, continuous rental, and rental with all or part of the rental applicable toward purchase. Most forms of rental include servicing. Direct purchase can include a service contract. Rental rates are of the order of 3 per cent of the direct purchase price per month. The sale and lease policy of various manufacturers is given under the sub-heading "COST, PRICE AND RENTAL RATE" in Chapter II.

Table XIV shows the nominal price one may expect to pay for a basic system. For many systems, one might add 20 to 80 per cent for required peripheral equipment. Most prices include installation but not shipping costs. Some of the figures reflect prices which are not current and have not taken into account general price rises during the past several years. Some figures include initial service or some type of warranty. The figures quoted in Table XIV are for general consideration only, and are not for purposes of acquisition. Indeed, many systems are not available, even at the price quoted, since the price stated is actually the construction "cost" to the owner.

An attempt was made to discover whether a "system cost per tube" figure could be established. For the larger systems, the figure is of the order of 200 dollars per tube installed and for the smaller systems approximately 100 dollars per tube. However, a glance at Tables X and XIV will show that such a figure can be calculated with some difficulty. An attempt to determine a figure such as "cost per cubic foot" of electronic computing equipment would be equally difficult. Such exercises are left to the reader should such figures be of any interest.

PERSONNEL REQUIREMENTS

Personnel problems have confronted computing system operators and manufacturers from the very outset, in all phases of computer research, development, manufacture, installation, operation, improvement and servicing. Various grades of skills are required in the fields of engineering, physics and mathematics. Each large system has a crew of engineers and technicians for improving and servicing and a group of mathematicians and operators for problem analysis, coding and programming. In the very small systems, all of these functions may be performed by one or two persons. The systems descriptions in Chapter II show various estimates made by manufacturers and operators of what the personnel requirements are or should be for various systems. The estimates, in some cases, do not show the personnel required for overtime, vacations, illness and training purposes. Just as in any application of manpower to machines, it is necessary to provide sufficient manpower so as to maximize machine utilization whenever possible. Many installations consist of multimillion dollar computer complexes. Such large capital investments must be utilized at maximum efficiency in order to avoid severe losses. Twenty-four hour operation increases the daily output and provides for more efficient utilization of capital equipment. Ultimate requirements for personnel depend to a large extent upon the nature of the application, particularly as pertains to coders, programmers and analysts.

RELIABILITY, OPERATING EXPERIENCE AND TIME AVAILABILITY

The most discussed and most controversial issues in the field of computing machinery occur on the subjects of reliability, efficiency and system evaluation. The determination of the reliability of a system is difficult, primarily because of a lack of a common understanding or interpretation of the definitions of computer operating terms. What actually constitutes "good time" on a computing system? What is "down time", "scheduled engineering", "useful production and code checking"? An attempt has been made to provide working definitions of these and other terms in the revised Glossary of Computer Engineering and Programming Terminology given in Chapter V of this report. The very crude "Operating Ratio", as is used in the systems descriptions of Chapter II, is defined as the "Good Time" obtained on the machine divided by the total time one actually "Attempted (or Wanted) to Run" the system. The question arises as to where to put the time lost in scheduled engineering (preventive maintenance), since technically, one is not attempting to run the system during this period, yet the system is not actually "down". Many systems, are operated for 168 hours per week. The operating ratio for these systems would require that 168 be used as the denominator and the number of useful output hours as the numerator, yielding a much smaller (but perhaps truer) ratio than a system operated on an 8-hour 5-day week shift and using off-time for servicing. This latter type of operation may yield operating ratios of the order of .90 to 1.0 and give a false indication of reliability.

The question of how one determines the average error-free running period is also a difficult one. It may be estimated or calculated by actual counts of the periods of malfunction-free operation. It may be the period used as a guide by coders to prevent losses due to running for extended periods between obtaining output information, particularly where volatile storage media are being used. Many questions regarding the subject of "RELIABILITY, OPERATING EXPERIENCE AND TIME AVAILABILITY" are answered under this subheading in the computing systems descriptions given in Chapter II. A search of the system descriptions under this subheading will reveal those installations which have computer time available to organizations outside of the operating organization.

Many computing systems are approaching the age of retirement and replacement. Constant improvements have already replaced many of the original components of a system. The next few years will see the retirement of many of the older systems. Such retirement may take the form of salvage of parts, use for educational and training purposes, or scrap. Many older models are available at reduced prices. A used computer market is developing. In accepting a used computer, one must be prepared to accept a few headaches. Table XV shows how long some models of computing systems have been in existence.

ADDITIONAL FEATURES AND REMARKS

Under this subheading has been placed general information concerning specific computing systems which did not have a "place" in the previous fourteen subheadings. Included under this subheading are remarks concerning the pictures, information which arrived too late to be added to the system description under a proper heading, special features of the system and other miscellaneous items of information. Under this subheading one will find what manufacturers and users considered to be the outstanding features and unique system advantages of the particular system. Under this subheading are remarks concerning the labelling, storage, shipping and protection from humidity, temperature and physical, electrical, fire or other damage of magnetic tapes.

FUTURE PLANS

The electronic digital computer field is a dynamic one. Plans for acquisition and improvement of systems and components are continually being made and modified. The plans of various operators and manufacturers are given under the subheading "FUTURE PLANS" in the systems descriptions of Chapter II. Interesting to note are the transitions to new systems being made by many users. "Second generation" (solid state) computers are now at hand.

INSTALLATIONS

A primary source of information concerning electronic digital computing systems is the operating organizations. The acquisitional and operational problems of one organization may have already been solved in one way or another by other organizations. Benefiting from the experience of others can be profitable, if only to avoid mistakes. Under the subheading "INSTALLATIONS" in the systems descriptions of Chapter II, a list of the owners and operators of specific systems is given in order that contacts between owners and prospective owners may be established. Many co-operative "plans" have come into existence, under which owners or operators of specific systems have engaged in sharing computer experience. Many computer sharing contracts have been drawn and many computer centers have been established, offering computer time and personnel for the solution of customers' problems.

TABLE I

MANUFACTURERS OF COMPUTING SYSTEMS

MANUFACTURER	SYSTEM
Airborne Instruments Laboratory Deer Park Long Island, New York	MODAC 404, MODAC 410, MODAC 414, MODAC 5014
Alwac Computer Division El-Tronics, Incorporated 13040 S. Cerise Avenue Hawthorne, California	ALWAC II, ALWAC III E
Argonne National Laboratory 9700 South Cass Avenue Argonne, Illinois	GEORGE
Automation Management Incorporated P.O. Box 217 25 Brigham Street Westboro, Massachusetts	PERK I II
Autonetics Division North American Aviation Corporation 9150 E. Imperial Highway Downey, California	AN/MJQ 1 REDSTONE, FADAC, JUKEBOX, RECOMP I CP 266, RECOMP II, REPAC, VERDAN
Bell Telephone Laboratories, Incorporated Whippany, New Jersey	LEPRECHAUN
Bendix Computer Division Bendix Corporation 5630 Arbor Vitae Avenue Los Angeles 45, California	BENDIX CUBIC TRACKER, BENDIX D 12, BENDIX G 15, BENDIX G 20
Brookhaven National Laboratories Upton, New York	MERLIN
Burroughs Corporation 6071 Second Avenue Detroit 32, Michigan	BURROUGHS 204, BURROUGHS 205, BURROUGHS 220, BURROUGHS D 103, BURROUGHS D 104, BURROUGHS D 105, BURROUGHS D 107, BURROUGHS D 201, BURROUGHS D 202, BURROUGHS D 203, BURROUGHS D 204, BURROUGHS D 208, BURROUGHS D 209, BURROUGHS E 101, BURROUGHS E 102, BURROUGHS E 103, UDEC I II III
Computer Control Company Western Division 2251 Barry Avenue Los Angeles 64, California	CCC REAL TIME, SPEC
Concord Control Incorporated 1282 Soldiers Field Road Boston 35, Massachusetts	NUMERICORD
Control Data Corporation 501 Park Avenue Minneapolis 15, Minnesota	CDC 160, CDC 1604
Cubic Corporation 5575 Kearny Villa Road San Diego 11, California	CUBIC AIR TRAFFIC, CUBIC TRACKER
Digital Equipment Corporation Maynard, Massachusetts	PROGRAMMED DATA PROCESSOR
Digitronics Corporation Albertson Avenue Albertson, New York	DIGITRONIC CONVERTER

TABLE I (CONTINUED)

MANUFACTURERS OF COMPUTING SYSTEMS

MANUFACTURER	SYSTEM
Electronics Corporation of America Business Machines Division Cambridge 42, Massachusetts	MAGNEFILE B, MAGNEFILE D
General Electric Company Computer Department 13430 N. Black Canyon Highway Phoenix, Arizona	GENERAL ELECTRIC 100 ERMA, GENERAL ELECTRIC 210, GENERAL ELECTRIC 225, GENERAL ELECTRIC 250, GENERAL ELECTRIC 312, CARAC
General Mills Mechanical Division 1620 Central Avenue Minneapolis 13, Minnesota	GENERAL MILLS AD/ECS, GENERAL MILLS APSAC
Geotechnical Corporation 3401 Shiloh Road Garland, Texas	GEOTECH AUTOMATIC
Hampshire Engineering Company 2300 Washington Street Newton Lower Falls 62, Massachusetts	CCC 500, HAMPSHIRE TRIDS 932
Hogan Laboratories, Incorporated 155 Perry Street New York 14, New York	CIRCLE
HRB Singer, Incorporated Science Park State College, Pennsylvania	HRB SINGER
Hughes Aircraft Company Digital Systems Department Florence and Teale Streets Culver City, California	HUGHES ADV AIRBORNE III, HUGHES BM GUIDANCE, HUGHES D PAT, HUGHES DIGITAIR, HUGHES LRI X, HUGHES M 252
International Business Machines Corporation 590 Madison Avenue New York 22, N. Y.	AN/ASQ 28(v) EDC, AN/ASQ 28(v) MDC, AN/FSQ 7 AN/FSQ 8 (SAGE), AN/FSQ 31(v), AN/FSQ 32, AN/TYK 7v INFORMER, ASC 15, IBM 305 RAMAC, IBM 604, IBM 607, IBM 608, IBM 609, IBM 610, IBM 632, IBM 650 RAMAC, IBM 701, IBM 702, IBM 704, IBM 705 I II, IBM 705 III, IBM 709, IBM 1401, IBM 1410, IBM 1620, IBM 7070, IBM 7074, IBM 7080, IBM 7090, IBM CPC, IBM STRETCH, NORC, STORED PROGRAM DDA
Intelex Systems Incorporated 67 Broad Street New York 4, New York	INTELEX AIRLINE RESERVATION
Iowa State University Ames, Iowa	CYCLONE
ITT Laboratories 500 Washington Avenue Nutley 10, New Jersey	ITT BANK IN PROC, ITT SPES 025
J. B. Rea Company, Incorporated 2202 Broadway Santa Monica, California	READIX

TABLE I (CONTINUED)

MANUFACTURERS OF COMPUTING SYSTEMS

MANUFACTURER	SYSTEM
Laboratory for Electronics 1079 Commonwealth Avenue Boston 15, Massachusetts	DE 60, DIANA, RASTAC, RASTAD
Leeds and Northrup Company 4901 Stenton Avenue Philadelphia 44, Pennsylvania	LEEDS NORTHRUP 3000
Librascope Division General Precision Incorporated 808 Western Avenue Glendale 1, California	LGP 30, LIBRASCOPE 407, LIBRASCOPE AIR TRAFFIC LIBRASCOPE ASN 24, LIBRASCOPE CP 209, LIBRASCOPE MK 38, LIBRASCOPE MK 130, LIBRATROL 500, LIBRATROL 1000
Lincoln Laboratory Massachusetts Institute of Technology Lexington 73, Massachusetts	LINCOLN CG 24, LINCOLN TX 0, LINCOLN TX 2
Litton Industries Electronic Equipments Division 5500 Canoga Avenue Woodland Hills, California	LITTON C 7000, LITTON DATA ASSESSOR
Marchant Calculators, Incorporated Electronic Division Oakland 8, California	MINIAC II
Massachusetts Institute of Technology Digital Computer Laboratory Cambridge 39, Massachusetts	WHIRLWIND II
Michigan State University East Lansing, Michigan	MISTIC
Minneapolis Honeywell Regulator Company 2753 4th Avenue South Minneapolis 8, Minnesota	DATAMATIC 1000, HONEYWELL 290, HONEYWELL 800
Monroe Calculating Machine Company 555 Mitchell Street Orange, New Jersey	DISTRIBUTAPE, MONROBOT III, MONROBOT V, MONROBOT VI, MONROBOT IX, MONROBOT XI, MONROBOT MU
National Cash Register Company Dayton 9, Ohio	NATIONAL 102 A, NATIONAL 102 D, NATIONAL 107, NATIONAL 304, NATIONAL 315, NATIONAL 390
Norden Division United Aircraft Corporation 3501 Harbor Boulevard Costa Mesa, California	NORDEN VOTE TALLY
Norden Division United Aircraft Corporation 58 Commerce Road Stamford, Connecticut	SCRIBE
Oak Ridge National Laboratory Oak Ridge, Tennessee and Argonne National Laboratory Argonne, Illinois, jointly	ORACLE
Oklahoma University Norman, Oklahoma	OKLAHOMA UNIV

TABLE I (CONTINUED)

MANUFACTURERS OF COMPUTING SYSTEMS

MANUFACTURER	SYSTEM
Packard Bell Computer Corporation 1905 Armacost Avenue Los Angeles 25, California	PACKARD BELL 250, TRICE
Pennsylvania State University Electrical Engineering Department University Park, Pennsylvania	PENNSTAC
Philco Corporation 3900 Welsh Road Willow Grove, Pennsylvania	AN/TYK 6v BASICPAC, AN/TYK 4v COMPAC, PHILCO 1000, PHILCO 2000, PHILCO 3000, PHILCO CXPQ
Radio Corporation of America Electronic Data Processing Systems Division Camden 2, New Jersey	BIZMAC I, BIZMAC II, RCA 110, RCA 200, RCA 300, RCA 301, RCA 501, RCA 601
Ramo Wooldridge Division Thompson Ramo Wooldridge, Incorporated 8433 Fallbrook Avenue Canoga Park, California	RW 300, RW 400
The Rand Corporation 1700 Main Street Santa Monica, California	JOHNNIAC
Remington Rand Univac Division Sperry Rand Corporation 315 Park Avenue South New York 10, New York	AF/CRC, AN/USQ 20, ATHENA, BOGART, LOGISTICS, TARGET INTERCEPT, UNIVAC 60, UNIVAC 120, UNIVAC 490, UNIVAC 1101, UNIVAC 1102, UNIVAC 1103 1103A, UNIVAC 1105, UNIVAC 1107, UNIVAC FILE 0, UNIVAC FILE 1, UNIVAC LARC, UNIVAC SOLID STATE 80/90, UNIVAC STEP, UNIVAC I, UNIVAC II, UNIVAC III
Rice University Houston 1, Texas	RICE UNIVERSITY
Royal McBee Corporation Port Chester, New York	RPC 4000, RPC 9000
Sylvania Electric Products, Incorporated 189 B Street Needham 94, Massachusetts	MOBIDIC A, MOBIDIC B, MOBIDIC C D AND 7A, SYLVANIA S 9400, SYLVANIA UDOFTT
The Teleregister Corporation 445 Fairfield Avenue Stamford, Connecticut	TELEREGISTER MAGNET BID ASKED, TELEREGISTER MAGNET INVENT CONT, TELEREGISTER TELEFILE, TELEREGISTER UNIFIED AIRLINE
Underwood Corporation 1 Park Avenue New York 16, New York	ELECOM 50, ELECOM 100, ELECOM 120, ELECOM 125 125 FP
University of California Los Alamos Scientific Laboratory P.O. Box 1663 Los Alamos, New Mexico	MANIAC I, MANIAC II
University of Chicago Institute for Computer Research Chicago 37, Illinois	MANIAC III
University of Illinois Digital Computer Laboratory Urbana, Illinois	ILLIAC, ORDVAC

TABLE I (CONTINUED)

MANUFACTURES OF COMPUTING SYSTEMS

MANUFACTURER	SYSTEM
University of Pennsylvania Moore School of Electrical Engineering Philadelphia, Pennsylvania	EDVAC
University of Wisconsin Department of Electrical Engineering Madison 6, Wisconsin	WISC
U. S. Army Ordnance Corps Ballistic Research Laboratories Aberdeen Proving Ground, Maryland	BRLESC
U. S. Navy Naval Research Laboratory Washington 25, D.C.	NAREC, UNIVERSAL DATA TRANS
U. S. Department of Commerce National Bureau of Standards Data Processing Systems Division Connecticut and Van Ness Avenues Washington 25, D.C.	AMOS IV, DYSEAC, SEAC, SWAC
Western Reserve University Center for Documentation and Communications Research Cleveland 6, Ohio	WRU SEARCHING SELECTOR
Westinghouse Electric Corporation Air Arm Division Box 746 Baltimore 3, Maryland	WESTINGHOUSE AIRBORNE

TABLE II

QUANTITY OF COMPUTING SYSTEMS MANUFACTURED OR OPERATIONAL

Quantity	System
Over 2,993	IBM 604
(Est All Models) 1,500	IBM 650
693	IBM CPC
462	LGP 30
Over 400	LIBRATROL 500
Over 300	BENDIX G 15
Over 267	IBM 607
(Incl E 101) 210	BURROUGHS E 103
200	UNIVAC STEP
180	VERDAN
(Incl Mod 1) 164	UNIVAC FILE 0
164	UNIVAC FILE 1
127	BURROUGHS E 101
(Incl 204) 112	BURROUGHS 205
110	UNIVAC SOLID STATE 80/90
100	BURROUGHS D 104
Over 90	IBM 1401
(Est) 70	IBM 704
70	MONROBOT IX
50	AN/FSQ 7 AN/FSQ 8 (SAGE)
48	LIBRASCOPE CP 209
45	UNIVAC 1105
42	BURROUGHS 220
Over 30	IBM 709
25	UNIVAC III
24	RCA 501
Over 18	IBM 701
18	GE 100 ERMA
18	RW 300
16	NATIONAL 102 A
14	LIBRASCOPE MK 38
Over 13	IBM 702
Over 13	IBM 705 III
Over 13	UNIVAC 1103 1103A
Over 12	BURROUGHS 204
12	TELEREGISTER UNIFIED AIRLINE
10	CDC 1604
10	JUKEBOX
10	RPC 4000
10	RPC 9000
9	DE 60
Over 8	IBM 7090

Quantity	System
Over 8	RECOMP II
8	GENERAL ELECTRIC 210
8	NUMERICORD
Over 7	UNIVAC II
7	AN/TYK 6v BASICPAC
7	CDC 160
7	CUBIC TRACKER
7	MONROBOT XI
Over 6	PHILCO 2000
6	ELECOM 125 125FP
6	NATIONAL 304
6	NATIONAL 390
6	READIX
Over 5	BURROUGHS E 102
Over 5	DATAMATIC 1000
5	BURROUGHS D 204
5	ELECOM 120
5	FOSDIC
5	TRICE
Over 4	NATIONAL 102 D
Over 4	UNIVAC 120
4	GENERAL ELECTRIC 312
4	ILLIAC
4	LIBRASCOPE ASN 24
4	RW 400
3	ALWAC III E
(Incl All Models) 3	BIZMAC I
(Incl All Models) 3	BIZMAC II
3	DIGITRONIC CONVERTER
3	DISTRIBUTAPE
3	ELECOM 50
3	ELECOM 100
3	HRB SINGER
3	PACKARD BELL 250
3	UNIVAC 1102
2	ALWAC II
2	CIRCLE
2	GENERAL MILLS AD/ECS
2	IBM STRETCH
2	LIBRASCOPE AIR TRAFFIC
2	PHILCO 3000
2	UDEC I II III

TABLE II (CONTINUED)

QUANTITY OF COMPUTING SYSTEMS MANUFACTURED OR OPERATIONAL

Quantity	System
2	WESTINGHOUSE AIRBORNE
1	AF/CRC
1	AMOS IV
1	AN/USQ 20
1	BOGART
1	BRLESC
1	BURROUGHS D 201
1	BURROUGHS D 202
1	CCC REAL TIME
1	COMPAC
1	CUBIC AIR TRAFFIC
1	CYCLONE
1	DIANA
1	DYSEAC
1	EDVAC
1	GENERAL MILLS APSAC
1	GEORGE
1	GEOTECH AUTOMATIC
1	HAMPSHIRE CCC 500
1	HAMPSHIRE TRIDS 932
1	INTELEX AIRLINE RESERVATION
1	ITT BANK IN PROC
1	ITT SPES 025
1	JOHNNIAC
1	LEPRECHAUN
1	LIBRASCOPE MK 130
1	LINCOLN CG 24
1	LINCOLN TX 0
1	LINCOLN TX 2
1	LOGISTICS
1	MAGNEFILE B
1	MAGNEFILE D
1	MANIAC I
1	MANIAC II
1	MANIAC III
1	MERLIN
1	MINIAC II
1	MISTIC
1	MOBIDIC A
1	MOBIDIC B
1	MOBIDIC C D & 7A
1	MODAC 404
1	MODAC 410
1	MODAC 414
1	MODAC 5014
1	MONROBOT III
1	MONROBOT V
1	NAREC
1	NATIONAL 107
1	NATIONAL 315
1	NORC
1	NORDEN VOTE TALLY
1	OARAC
1	OKLAHOMA UNIVERSITY
1	ORACLE
1	ORDVAC
1	PENNSTAC
1	PERK I II
1	PHILCO 1000
1	PHILCO CXPQ
1	PROGRAMMED DATA PROCESSOR
1	RASTAD
1	RCA 200
1	RCA 300
1	RCA 301
1	RCA 601
1	RECOMP I CP 266
1	REPAC
1	RICE UNIVERSITY
1	SEAC
1	SPEC
1	STORED PROGRAM DDA
1	SWAC
1	SYLVANIA S 9400
1	SYLVANIA UDOFTT
1	TARGET INTERCEPT
1	TELEREGISTER MAGNET BID ASKED
1	TELEREGISTER MAGNET INVENT CONT
1	UNIVAC 490
1	UNIVAC 1101
1	UNIVAC LARC
1	UNIVERSAL DATA TRANS
1	WHIRLWIND II
1	WISC
1	WRU SEARCHING SELECTOR

TABLE III

WORD LENGTH OF COMPUTING SYSTEMS

WORD LENGTH DIGITS	ARITHMETIC POINT	INSTRUCTIONS PER WORD	ADDRESSES PER WORD	SYSTEM
Variable	Fixed	3	-	BIZMAC I
Variable	Fixed	3	-	BIZMAC II
Variable	Fixed	1	2	DIANA
Variable	-	-	-	FOSDIC
Variable	Fixed	-	2	IBM 305 RAMAC
Variable	Fixed	-	1	IBM 702
Variable	Fixed	-	1	IBM 705 I II
Variable	Fixed	-	1	IBM 705 III
Variable	Fixed	-	1 or 2	IBM 1401
Variable	-	-	-	IBM 1410
Variable	Fixed	-	2	IBM 1620
Variable	Fixed	-	1	IBM 7080
Variable	-	Variable	1	RASTAC
Variable	-	2	-	RASTAD
Variable	Fixed	Variable	2	RCA 301
Variable	Fixed	Variable	2	RCA 501
Variable	Fixed and Floating	1 or 2	1, 2 or 3	RCA 601
Variable	-	1 to 3	1	SCRIBE
Variable	-	-	1	TELEREGISTER TELEFILE
Variable	Fixed	-	3	UNIVAC 60
Variable	Fixed	-	3	UNIVAC 120
Variable	Fixed	-	1	AMOS IV
3 Dec	-	0.5	1 or 2	NATIONAL 315
3 Dec	Fixed	2 or 4	1	CDC 160
12 Bin	Fixed	1	1	RCA 300
13 Bin	Fixed	1	1	SPEC
13 Bin	Fixed	1	-	LIBRASCOPE CP 209
14 Bin	Fixed	1, 2 or 3	-	NORDEN VOTE TALLY
3 Dec + 5 Bin	Fixed	-	-	BURROUGHS D 209
16 Bin	Fixed	0.5	-	HRB SINGER
16 Bin	-	-	1	WHIRLWIND II
16 Bin	Fixed	1	3 Mod	HUGHES DIGITAIR
17 Bin	Fixed	1	2	HUGHES ADV AIRBORNE III
17 Bin	Fixed	1	1 or 2	IBM 604
3 or 5 Dec	Fixed	-	1 or 2	IBM 607
3 or 5 Dec	Fixed	-	1 or 2	IBM CPC
3 or 5 Dec	Fixed	-	1	LEPRECHAUN
17 Bin	Fixed	1	1	HONEYWELL 290
18 Bin	Fixed and Floating	1	1, 2 or 4	LIBRASCOPE MK 38
18 Bin	Fixed	1	1	LINCOLN TX 0
18 Bin	-	1	1	PROGRAMMED DATA PROCESSOR
18 Bin	Fixed	1		

TABLE III (CONTINUED)

WORD LENGTH OF COMPUTING SYSTEMS

WORD LENGTH DIGITS	ARITHMETIC POINT	INSTRUCTIONS PER WORD	ADDRESSES PER WORD	SYSTEM
18 Bin	Fixed	0.5	1 + 1	RW 300
19 Bin	Fixed	1	3	HUGHES D PAT
19 Bin	Fixed	1	3	HUGHES LRI X
19 Bin	Fixed	1	1	LIBRASCOPE MK 130
20 Bin	Floating	1	1	BURROUGHS D 103
20 Bin	Fixed	-	-	CUBIC AIR TRAFFIC
20 Bin	Fixed and Floating	1	1	GENERAL ELECTRIC 225
20 Bin	Fixed	1 + 1	1	GENERAL ELECTRIC 312
20 Bin	Fixed	-	-	HAMPSHIRE CCC 500
20 Bin	Fixed	2	1	HUGHES M 252
20 Bin	-	0.5	1	MODAC 5014
20 Bin	-	-	1	RCA 200
6 Dec	Fixed	1	1	GENERAL ELECTRIC 210
6 Dec	Fixed	-	1	MODAC 404
6 Dec	Fixed	-	1	MODAC 414
21 Bin	Fixed	1	1	BURROUGHS D 201
21 Bin	Fixed	-	-	CUBIC TRACKER
21 Bin	Fixed	1 or 0.5	1 or 1 + 1	LEEDS NORTHROP 3000
21 Bin	Fixed	1	1	LITTON C 7000
21 Bin	Fixed	1	1	SYLVANIA UDOFTT
22 Bin	Fixed	1	1	BURROUGHS D 202
22 Bin	Fixed	-	-	HAMPSHIRE TRIDS 932
22 Bin	Fixed	1	4	LIBRASCOPE 407
22 Bin	Fixed	1	1	PACKARD BELL 250
22 Bin	Fixed	1	1 or 1 + 1	PHILCO 3000
22 Bin	Fixed	5	-	STORED PROGRAM DDA
23 Bin	Fixed	1	1	AN/ASQ 28 (v) MDC
7 Dec	-	-	-	GE 100 ERMA
24 Bin	Fixed	1	1	ATHENA
24 Bin	Fixed	1	1 + 1	BURROUGHS D 203
24 Bin	Fixed	1	1	BURROUGHS D 208
24 Bin	-	-	-	TELEREGISTER MAGNET BID ASKED
24 Bin	Fixed	-	1	RCA 110
24 Bin	Fixed	1	1	TARGET INTERCEPT
24 Bin	Fixed	1	1	UNIVAC 1101
24 Bin	-	1	1	UNIVAC 1102
24 Bin	Fixed	1	1 + 1	UNIVAC III
24 Bin	Fixed	1	1.5	VERDAN
24 Bin	Fixed	1	1	WESTINGHOUSE AIRBORNE
25 Bin	Fixed	1	1 + 1	CCC REAL TIME
25 Bin	Fixed	1	1 + 1	LIBRASCOPE ASN 24

TABLE III (CONTINUED)

WORD LENGTH OF COMPUTING SYSTEMS

WORD LENGTH DIGITS	ARITHMETIC POINT	INSTRUCTIONS PER WORD	ADDRESSES PER WORD	SYSTEM
25 Bin	Fixed	1	1	LINCOLN CG 24
26 Bin	Fixed	1	1 + 1	AN/ASQ 28 (v) EDC
26 Bin	Fixed	1	2	RW 400
27 Bin	Fixed	3	2	ASC 15
27 Bin	Fixed	-	-	TRICE
8 Dec	Fixed	-	-	BENDIX D 12
8 Dec	Fixed and Floating	1	3	ELECOM 120
8 Dec	Fixed	1	1	LIBRASCOPE AIR TRAFFIC
8 Dec	Fixed	-	1	MAGNEFILE B
29 Bin	Fixed	-	-	BENDIX CUBIC TRACKER
29 Bin	Fixed	1	2	BENDIX G 15
30 Bin	Fixed	1	1	AN/USQ 20
30 Bin	Fixed	1	3	ELECOM 100
30 Bin	Fixed	-	1	UNIVAC 490
9 Dec	Fixed	-	1 or 2	IBM 608
31 Bin	Fixed	-	1	BURROUGHS D 204
31 Bin	Fixed	1	1	LIBRATROL 500
32 Bin	Fixed	1	1	AN/FSQ 7 AN/FSQ 8 (SAGE)
32 Bin	Fixed	1	1	LIBRATROL 1000
32 Bin	Fixed	1	1	LITTON DATA ASSESSOR
32 Bin	Fixed	1	1	LGP 30
32 Bin	Fixed	2	1	MONROBOT XI
32 Bin	Fixed	1	1 over 1	RPC 4000
33 Bin	Fixed	0, 1, 2, 3, 4	1	ALWAC II
33 Bin	Fixed	2, 3, 4	1	ALWAC III E
33 Bin	1	1	1	BENDIX G 20
33 Bin	Fixed	1	1	ITT SPES 025
34 Bin	Fixed	1	1	BURROUGHS D 107
10 Dec	Fixed	-	-	AF/CRC
10 Dec	Fixed and Floating	1	1	BURROUGHS 204
10 Dec	Fixed and Floating	1	1	BURROUGHS 205
10 Dec	Fixed and Floating	1	1	BURROUGHS 220
10 Dec	Fixed	-	-	ELECOM 50
10 Dec	Fixed and Floating	1	2	ELECOM 125 125FP
10 Dec	Fixed and Floating	1	1	IBM 650 RAMAC TAPES
10 Dec	Fixed and Floating	1	1	IBM 7070
10 Dec	Fixed and Floating	1	1	IBM 7074
10 Dec	Fixed	1	1	INTELEX AIRLINE RESERVATION
10 Dec	Fixed	1	1	MINIAC II
10 Dec	Fixed	-	1	MODAC 410
10 Dec	Fixed	1	2	OARAC

TABLE III (CONTINUED)

WORD LENGTH OF COMPUTING SYSTEMS

WORD LENGTH DIGITS	ARITHMETIC POINT	INSTRUCTIONS PER WORD	ADDRESSES PER WORD	SYSTEM
10 Dec	Fixed and Floating	-	1	READIX
10 Dec	Fixed	2	1 or 2	UDEC I II III
10 Dec	Fixed	1	1.5	UNIVAC SOLID STATE 80/90
10 Dec	Fixed	1	1.5	UNIVAC STEP
35 Bin	Fixed	1	1 + 1	FADAC
36 Bin	Fixed	2	1	GENERAL MILLS APSAC
36 Bin	Fixed	2	1	IBM 701
36 Bin	Fixed and Floating	1	1	IBM 704
36 Bin	Fixed and Floating	1	1	IBM 709
36 Bin	Fixed and Floating	1	1	IBM 7090
36 Bin	-	1	2	PHILCO 1000
36 Bin	Fixed and Floating	1	2	UNIVAC 1103 1103A
36 Bin	Fixed and Floating	1	2	UNIVAC 1105
36 Bin	Fixed and Floating	-	1	UNIVAC 1107
36 Bin	-	-	-	UNIVERSAL DATA TRANS
9 Dec + 6 Bin	Fixed	1	3	NATIONAL 102 D
37 Bin	Fixed	1	1	AN/TYK 6v BASICPAC
37 Bin	Fixed	2	1	GENERAL MILLS AD/ECS
37 Bin	Fixed	1	4	SWAC
37 Bin	Fixed and Floating	1	1	SYLVANIA S 9400
37 Bin	-	-	-	TELEREGISTER MAGNET INVENT CONT
11 Dec	Fixed	1	3	NATIONAL 107
11 Dec	Fixed	1	1 + 1	PENNSTAC
38 Bin	Fixed	1	1	AN/TYK 7v INFORMER
38 Bin	Fixed	1	1	COMPAC
38 Bin	Fixed	1	1	LINCOLN TX 2
38 Bin	Fixed	1	1 or 2	MOBIDIC A
38 Bin	Fixed	1	1 or 2	MOBIDIC B
38 Bin	Fixed	1	1 or 2	MOBIDIC C D & 7A
40 Bin	Fixed	2	1	CYCLONE
40 Bin	Fixed and Floating	Variable	2	GEORGE
40 Bin	Fixed	2	1	ILLIAC
40 Bin	Fixed	2	1	JOHNNIAC
40 Bin	Fixed	2	2	JUKEBOX
40 Bin	Fixed	2	1	MANIAC I
40 Bin	Fixed	2	1	MISTIC
40 Bin	Fixed	2	1	ORACLE
40 Bin	Fixed	2	1	ORDVAC
40 Bin	Fixed	2	1	RECOMP I CP 266
40 Bin	Fixed and Floating	2	1	RECOMP II

TABLE III (CONTINUED)

WORD LENGTH OF COMPUTING SYSTEMS

WORD LENGTH DIGITS	ARITHMETIC POINT	INSTRUCTIONS PER WORD	ADDRESSES PER WORD	SYSTEM
40 Bin	Fixed and Floating	2	1	REPAC
12 Dec	Fixed	1	1	BURROUGHS E 101
12 Dec	Fixed	1	1	BURROUGHS E 102
12 Dec	Fixed	-	1	BURROUGHS E 103
12 Dec	Fixed	1	3	DATAMATIC 1000
12 Dec	-	-	2	IBM 609
12 Dec	Fixed	-	1	IBM 632
12 Dec	Fixed	1	1	ITT BANK IN PROC
12 Dec	Fixed	-	3	LOGISTICS
12 Dec	Fixed	1	4	NATIONAL 390
12 Dec	Fixed	6	1	RPC 9000
12 Dec	Fixed	2	1	UNIVAC I
12 Dec	Fixed	2	1	UNIVAC II
12 Dec	Fixed and Floating	1	1	UNIVAC LARC
42 Bin	Fixed	1	3	NATIONAL 102 A
44 Bin	Fixed	2	1	CIRCLE
44 Bin	Fixed and Floating	1	4	EDVAC
45 Bin	Fixed	1	3	DYSEAC
45 Bin	Fixed	1	3 or 4	SEAC
48 Bin	Fixed and Floating	2	1	CDC 1604
48 Bin	Fixed and Floating	1	3	HONEYWELL 800
48 Bin	Fixed and Floating	2	1	MANIAC II
48 Bin	Floating	1	2	MANIAC III
48 Bin	Fixed and Floating	1	1 or 2	MERLIN
48 Bin	Fixed	2	1	NAREC
48 Bin	Fixed and Floating	2	1	PHILCO 2000
48 Bin	Fixed	2	1	PHILCO CXPQ
50 Bin	Fixed and Floating	1	1	AN/FSQ 31 (v)
50 Bin	Fixed and Floating	1	1	AN/FSQ 32
50 Bin	Fixed and Floating	1	3	WISC
15 Dec	Fixed and Floating	-	1	IBM 610
52 Bin	-	-	-	BURROUGHS D 104
54 Bin	Floating	1	1 or 3	OKLAHOMA UNIVERSITY
54 Bin	Fixed and Floating	1	1	RICE UNIVERSITY
16 Dec	Fixed and Floating	1	3	NORC
10 Alphanum	Fixed and Floating	0.5 to 6	1 or 3	NATIONAL 304
62 Bin	Fixed	-	1	MONROBOT IX
18 Dec	Fixed	-	up to 5	DE 50
64 Bin	Fixed and Floating	1 or 2	1 or 2	IBM STRETCH
68 Bin	Fixed and Floating	3	1	BRLESC
20 Dec	Fixed	1	4	MONROBOT III
20 Dec	Fixed	-	4	MONROBOT V
20 Dec	Fixed	2	4	MONROBOT VI

TABLE III (CONTINUED)

WORD LENGTH OF COMPUTING SYSTEMS

WORD LENGTH DIGITS	ARITHMETIC POINT	INSTRUCTIONS PER WORD	ADDRESSES PER WORD	SYSTEM
12 Alphanum	Fixed	1	3	UNIVAC FILE 0
12 Alphanum	Fixed	13	3	UNIVAC FILE 1
96 Bin	Fixed	2	3	MONROBOT MU
42 Dec	Fixed	-	1	MAGNEFILE D
Variable	Fixed	3	-	BIZMAC I
Variable	Fixed	3	-	BIZMAC II
Variable	Fixed	1	2	DIANA
Variable	-	-	-	FOSDIC
Variable	Fixed	-	2	IBM 305 RAMAC
Variable	Fixed	-	1	IBM 702
Variable	Fixed	-	1	IBM 705 I II
Variable	Fixed	-	1	IBM 705 III
Variable	Fixed	-	1 or 2	IBM 1401
Variable	-	-	-	IBM 1410
Variable	Fixed	-	2	IBM 1620
Variable	Fixed	-	1	IBM 7080
Variable	-	Variable	1	RASTAC
Variable	-	2	-	RASTAD
Variable	Fixed	Variable	2	RCA 301
Variable	Fixed	Variable	2	RCA 501
Variable	Fixed and Floating	1 or 2	1, 2 or 3	RCA 601
Variable	-	1 to 3	1	SCRIBE
Variable	Fixed	-	1	TELEREGISTER TELEFILE
Variable	Fixed	-	3	UNIVAC 60
Variable	Fixed	-	3	UNIVAC 120

Systems indicated as "floating-point systems have built-in automatic "floating-point" circuitry.

"Fixed-point" systems may be programmed for "floating-point" operation through the use of sub-routines.

TABLE IV

ARITHMETIC OPERATION TIME (EXCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
0.75	300	600	PROGRAMMED DATA PROCESSOR
0.8	7.4	24	UNIVAC 1107
1	1,000	1,000	LINCOLN TX 0
1 - 3.0	20	60	BRLESC
1.38 - 1.50	2.48 - 2.70	9.00 - 9.90	IBM STRETCH
1.4	5 to 17 (9x36 Bits)	17.2 to 75 (9/36)	LINCOLN TX 2
1.4	20	40	WESTINGHOUSE AIRBORNE
1.7	40.3	43	PHILCO 2000
2	25 - 100	100	BURROUGHS D 204
2	22	42	LITTON C 7000
2.5 - 27.5	14 - 61.5	5 - 63.5	AN/FSQ 31 (v)
2.5 - 27.5	14 - 61.5	56.5 - 70	AN/FSQ 32
3	56	68	BURROUGHS D 201
3	34	73	BURROUGHS D 202
3	-	-	ITT SPES 025
3 - 4	100	100	OKLAHOMA UNIVERSITY
3 - 7	26 - 485	27 - 595	GEORGE
3.5	130	320	MERLIN
4	39	40	SYLVANIA S 9400
4	8	28	UNIVAC LARC
4.8 - 12	7.2 - 72	72	UNIVAC 490
5	20	40	TARGET INTERCEPT
5	260	324	UNIVAC 1101
5.3	296	-	SWAC
5.5	130	200	PHILCO 1000
6.0	10.5	45.0	AN/FSQ 7 AN/FSQ 8 (SAGE)
6	48 - 90	48 - 90	LITTON DATA ASSESSOR
6	450	650	NAREC
6	10	25	RCA 601
6.4	1,000	1,800	CDC 160
6.6	-	-	NORDEN VOTE TALLY
7.8	-	-	FADAC
8	78	88	MOBIDIC A
8	78	80	MOBIDIC C D & 7A
8	-	-	ORACLE
9	76.5 - 185.5	76.5 - 312.5	UNIVAC III
9.6	35.2 - 112	112	AN/USQ 20
10	-	-	CUBIC TRACKER
10	385	385	JOHNNIAC
10	-	-	TELEREGISTER UNIFIED AIRLINE
12	240	240	COMPAC
12	74	74	LINCOLN CG 24
12	276	252	PACKARD BELL 250

TABLE IV (CONTINUED)

ARITHMETIC OPERATION TIME (EXCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
12	86	156	RCA 300
12.7	376	400	AN/TYK 7v INFORMER
13	56	98	BENDIX G 20
13	-	-	SPEC
14	700	700	ORDVAC
15	31	227	NORC
16	16 to 400	16 to 436	LIBRASCOPE MK 130
17	264	340	UNIVAC 1102
18 + n/2	65	75	MANIAC III
20	230	480	GENERAL ELECTRIC 225
21.5	430,000	-	IBM 632
22	356	370	LIBRASCOPE AIR TRAFFIC
23/Dig	-	-	IBM 702
24	264	288	AN/ASQ 28 (v) MDC
24 or 48	444	444	IBM 701
25	50	-	CCC REAL TIME
26	700	750	BURROUGHS D 208
28	223	470	UNIVAC 1103 1103 A
32	518	1,168	GENERAL ELECTRIC 210
34	80	-	MOBIDIC B
36	-	-	NATIONAL 315
36	110	472	UNIVAC 1105
40	520	1,000	ATHENA
40	620 - 820	900	ILLIAC
40	75	75	RICE UNIVERSITY
40 to 130	-	-	INTELEX AIRLINE RESERVATION
43	-	-	BENDIX D 12
48	2,112	2,112	DYSEAC
48	2,112	2,112	SEAC
58	835	2,131	DATAMATIC 1000
59	59	177	LIBRASCOPE CP 209
60	800	920	GENERAL MILLS AD/ECS
60	1,260	3,420	NATIONAL 304
70	960	1,170	CYCLONE
80	1,000	1,000	MANIAC I
80	980	1,080	MISTIC
80	2,000	2,000	VERDAN
84	84/Bit	84/Bit	HUGHES D PAT
84	84/Bit	84/Bit	HUGHES LRI X
85	-	-	UNIVAC SOLID STATE 80/90
85	-	-	UNIVAC STEP
86	3,000	3,000	BURROUGHS D 203

TABLE IV (CONTINUED)

ARITHMETIC OPERATION TIME (EXCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
88	968	1,936	HUGHES M 252
88 - 176	3,912	5,912	UDEC I II III
91	800	1,200	OARAC
94	2,985	5,076	PENNSTAC
96	1,920	2,496	GENERAL ELECTRIC 312
100	760	1,320	HONEYWELL 290
100	2,000	4,000	LIBRASCOPE 407
105	105 + 105/Bit	105/Bit	HUGHES DIGITAIR
80 + 16 (Aug + Add)	-	-	TELEREGISTER TELEFILE
120	1,500	-	GENERAL MILLS APSAC
120	1,680	2,990	UNIVAC II
130	2,730	2,730	LEEDS NORTHROP 3000
132	2,772	2,772	PHILCO 3000
156	3,276	3,276	AN/ASQ 28 (v) EDC
156	1,872	-	ASC 15
156	3,907	4,063	LIBRASCOPE ASN 24
120 + 40C	160 + 288N + 145MN	Prog	BIZMAC I
120 + 40C	-	-	BIZMAC II
170	680 - 10, 710	-	ITT BANK IN PROC
185	2,055	3,970	BURROUGHS 220
186	2,577	4,270	DIANA
200	1,700	1,700	HUGHES ADV AIRBORNE III
220	1,760	5,300	HAMPSHIRE TRIDS 932
220	11,000	13,420	IBM 608
230	1,980	3,520	RPC 9000
240	--	-	MODAC 404
240 - 420	1,900 - 9,600	1,300 - 2,400	RCA 501
250	250	-	CUBIC AIR TRAFFIC
250	17,000	17,000	LGP 30
250	15,000	15,000	LIBRATROL 500
250	16,250	16,250	LIBRATROL 1000
250	17,000	17,000	RPC 4000
270	-	-	BENDIX G 15
282.6	1,907.6	3,707.6	UNIVAC I
288	8,000	8,000	MODAC 414
330	18,300	18,700	ELECOM 120
330	18,300	18,700	ELECOM 125 125FP
428	8,500	8,000	HAMPSHIRE CCC 500
440	16,000	24,000	REDIX
450	13,600	14,800	MINIAC II
500	20,000	20,000	CIRCLE
500	14,000	17,000	IBM 604

TABLE IV (CONTINUED)

ARITHMETIC OPERATION TIME (EXCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
520	12,940	15,700	IBM 607
540	10,800	11,340	JUKEBOX
540	10,800	10,800	REPAC
600	7,000	7,000	MODAC 410
650	39,000	-	ELECOM 50
672 - 768	2,210 - 19,600	6,000 - 23,400	IBM 650 RAMAC TAPES
760	13,180	15,480	IBM CPC
780	2,990	3,120	RW 300
1,000	32,000	32,000	ALWAC II
1,000	17,000	17,000	ALWAC III E
1,000	20,000	20,500	RECOMP I CP 266
1,200	16,300	20,000	UNIVAC FILE 0
1,200	16,300	20,000	UNIVAC FILE 1
1,350	12,400	12,700	RECOMP II
3,000	140,000	140,000	DE 60
3,000	-	-	MONROBOT IX
3,000	28,000	500,000	MONROBOT XI
4,000	15,000	15,500	NATIONAL 102 D
7,400	25,000	25,800	NATIONAL 102 A
42,500	241,500	291,500	BURROUGHS E 103
100,000	-	-	MAGNEFILE D
150,000	-	-	MAGNEFILE B
280,000	1,155,000	1,155,000	IBM 610

TABLE V

ARITHMETIC OPERATION TIME (INCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
2.5 - 27.5	14 - 61.5	5 - 63.5	AN/FSQ 31 (v)
2.5 - 27.5	14 - 61.5	56.5 - 70	AN/FSQ 32
3	20	40	WESTINGHOUSE AIRBORNE
3.7 - 11.7	42.3 - 50.3	45 - 53.0	PHILCO 2000
4	26	46	LITTON C 7000
4	12.7	31	UNIVAC 1107
4	8	28	UNIVAC LARC
4.36 - 32.70	4.36 - 30.52	6.54 - 32.70	IBM 7090
4.8	9.6 to 19.2	19.6 to 80.0	LINCOLN TX 2
4.8 - 9.6	25.2 to 0.8N	63.6 - 66.4	CDC 1604
5	65	80	BURROUGHS D 103
5	300	600	PROGRAMMED DATA PROCESSOR
5	10	105	SYLVANIA UDOFTT
5 - 6	25	65	BRLESC
6	1,000	1,000	LINCOLN TX 0
6.4 - 19.2	-	-	CDC 160
7 - 16	108	108	OKLAHOMA UNIVERSITY
7.2 - 12	19.2 - 84	84	UNIVAC 490
8	140	330	MERLIN
8	43	44	SYLVANIA S 9400
9	76.5 - 184.5	76.5 - 312.5	UNIVAC III
9.75	13.75	28.75	RCA 601
10	40	80	BURROUGHS D 202
10	56	70	IBM 7074
10	25	45	TARGET INTERCEPT
10	-	-	TRICE
10.2 - 12.6	30 - 108	108	BURROUGHS D 204
12.0	16.5	51.0	AN/FSQ 7 AN/FSQ 8 (SAGE)
12	60 - 102	60 - 102	LITTON DATA ASSESSOR
13.08 (6 + 6)	140 (6 x 6)	210 (10/6)	IBM 7080
16	35.2 - 112	112	AN/USQ 20
16	-	-	ITT SPES 025
16	86	88	MOBIDIC A
16	86	88	MOBIDIC C D & 7A
17/Digit	-	-	IBM 705 I II
20	-	-	CUBIC TRACKER
20.7	392	425	AN/TYK 7v INFORMER
22	300 - 600	575 - 725	NAREC
22	-	-	STORED PROGRAM DDA
22	34 - 41	71	WHIRLWIND II
22 - 26	238 - 242	238 - 242	AN/TYK 6v BASICPAC

TABLE V (CONTINUED)

ARITHMETIC OPERATION TIME (INCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
24	264	288	AN/ASQ 28 (v) MDC
24	252	252	COMPAC
24	162	450	HONEYWELL 800
24	84	84	LINCOLN CG 24
24	96	168	RCA 300
24 + n/2	71	81	MANIAC III
24 - 84	24 - 240	36 - 240	IBM 704
24 - 84	24 - 240	36 - 240	IBM 709
25	75	75	BURROUGHS D 201
25	75	-	CCC REAL TIME
25	400	400	JOHNNIAC
26	700	750	BURROUGHS D 208
27	70	112	BENDIX G 20
32	-	-	BURROUGHS D 209
32	366	380	LIBRASCOPE AIR TRAFFIC
32	-	-	MODAC 5014
33	-	-	NORDEN VOTE TALLY
36	80	128	RW 400
36 or 60	456	456	IBM 701
40	230	426	BURROUGHS D 107
40	250	500	GENERAL ELECTRIC 225
40	375	520	LEPRECHAUN
40	40 to 424	40 to 460	LIBRASCOPE MK 130
42	88	-	MOBIDIC B
42	294	1,044	NATIONAL 315
44	239	486	UNIVAC 1103 1103 A
45	-	-	PHILCO CXPQ
50	85	85	RICE UNIVERSITY
50 to 140	-	-	INTELEX AIRLINE RESERVATION
56	728	868	RCA 110
59	59	177	LIBRASCOPE CP 209
60	116	508	UNIVAC 1105
64	550	1,200	GENERAL ELECTRIC 210
64	368	-	SWAC
70	370 - 590	590	ORACLE
72 (10 + 10)	672 to 1,488 (10 x 10)	792 to 984	IBM 7070
80	840	940	GENERAL MILLS AD/ECS
84	84 + 84/Bit	84 + 84/Bit	HUGHES LRI X
86	3,000	3,000	BURROUGHS D 203
90	300 - 1,700	-	AF/CRC
93	665 - 865	950	ILLIAC

TABLE V (CONTINUED)

ARITHMETIC OPERATION TIME (INCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
95.8	770.8	3,159.2	IBM 705 III
100	990	1,200	CYCLONE
100	1,000	1,100	MISTIC
108	372	348	PACKARD BELL 250
120	1,520	16,200	GENERAL MILLS APSAC
120	540	540	MONROBOT V
120	1,320	3,480	NATIONAL 304
160	1,720	3,030	UNIVAC II
160	-	-	VERDAN
170	680 - 10, 710	-	ITT BANK IN PROC
176 - 264	4,000	6,000	UDEC I II III
192	2,016	2,592	GENERAL ELECTRIC 312
160 + 16 (Aug + Add)	80 + 16	80 + 16	TELEREGISTER TELEFILE
192 - 1,536	2,208 - 3,552	2,256 - 3,600	EDVAC
192 - 1,536	2,304 - 3,648	2,304 - 3,648	DYSEAC
192 - 1,540	2,300 - 3,650	2,300 - 3,650	SEAC
200	2,070	3,985	BURROUGHS 220
200	860	1,420	HONEYWELL 290
210	105 + 105/Bit	105/Bit	HUGHES DIGITAIR
210	7,800	-	RCA 301
220	1,760	5,300	HAMPSHIRE TRIDS 932
221	-	-	SPEC
224	13,860 (6 x 6)	17,640 (6/6)	IBM 609
230.4	1,008	2,304	DATAMATIC 1000
250	250	-	CUBIC AIR TRAFFIC
264	1,144	2,112	HUGHES M 252
300	1,960	2,170	IBM 1401
312	2,028	-	ASC 15
400 - 17,000	10,000 - 26,000	10,000 - 26,000	OARAC
428	8,500	8,000	HAMPSHIRE CCC 500
440	25,000	40,000	READIX
500	500 - 1,000	-	LOGISTICS
500	17,000	17,000	RPC 4000
525	2,150	3,950	UNIVAC I
540	2,430 - 16,700	2,430 - 16,700	BENDIX G 15
540	10,800	11,300	RECOMP II
560	3,137	4,830	DIANA
624	3,744	3,744	AN/ASQ 28 (v) EDC
625	4,219	4,375	LIBRASCOPE ASN 24
780	2,990	3,120	RW 300
910	3,600	3,600	LEEDS NORTHROP 3000

TABLE V (CONTINUED)

ARITHMETIC OPERATION TIME (INCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
924	4,224	4,224	PHILCO 3000
960 (10 Dig)	17,700 (10 Dig)	16.8	IBM 1620
1,000	17,000	17,000	ALWAC III E
1,000	17,000	17,000	LIBRATROL 1000
1,019 - 1,188	9,300	12,680	BURROUGHS 204
1,019 - 1,188	9,300	12,680	BURROUGHS 205
1,110	2,860	3,520	RPC 9000
1,360	1,275	1,275	UNIVAC SOLID STATE 80/90
1,360	1,275 +	1,275 +	UNIVAC STEP
1,980	22,240	22,740	REPAC
2,000	21,000	21,500	RECOMP I CP 266
3,445	5,335	7,426	PENNSTAC
3,500	22,000	22,000	ELECOM 125 125FP
7,750	23,000	23,000	LIBRATROL 500
7,800	21,000 to 49,100	21,000 to 53,200	NATIONAL 102 D
8,000	17,000	17,000	LGP 30
8,000	8,000	8,000	MODAC 414
8,000	68,000	77,000	MONROBOT MU
8,700	23,800	27,500	UNIVAC FILE 0
8,700	23,800	27,500	UNIVAC FILE 1
9,000	34,000	500,000	MONROBOT XI
9,590	19,850	20,390	JUKEBOX
11,000	250,000	400,000	NATIONAL 390
11,200	24,300	25,600	MINIAC II
12,000	13,500	54,000	MONROBOT IX
15,000	40,000	40,000	NATIONAL 107
16,700	16,700	16,700	WISC
17,010	-	-	TELEREGISTER UNIFIED AIRLINES
19,900	37,500	38,500	NATIONAL 102 A
20,000	-	-	ELECOM 100
25,000	-	-	MODAC 404
30,000	60,000 - 190,000	100,000 - 370,000	IBM 305 RAMAC
50,000	250,000	250,000	BURROUGHS E 101
50,000	250,000	250,000	BURROUGHS E 102
51,000	250,000	300,000	BURROUGHS E 103
60,000	220,000	200,000	DE 60
110,000	2,500,000	-	IBM 632
120,000	540,000	540,000	MONROBOT III
135,000	600,000	600,000	MONROBOT VI

TABLE VI

ACCESS TIME OF HIGH SPEED STORAGE UNITS

ACCESS TIME MICROSECONDS	STORAGE MEDIUM	SYSTEM
0.2 - 0.8	MC	WESTINGHOUSE AIRBORNE
0.3 and 1.8	MC and TF	UNIVAC 1107
0.5 - 2.18	MC	IBM STRETCH
0.88	DL	RPC 9000
0.9 - 1.5	MC	RCA 601
1.0	-	MANIAC III
1.07	MC	UNIVAC III
1.9	MC	UNIVAC 490
2	MC	BRLESC
2	MC	BURROUGHS D 202
2	MC	BURROUGHS D 208
2 or 10	MC	PHILCO 2000
2.1	MC	HONEYWELL 800
2.2 and 3.4	MC	LINCOLN TX 2
2.4 and 15	MC and CRT	MANIAC II
2.5	MC	AN/FSQ 31 (v)
2.5	MC	AN/FSQ 32
2.5	MC	BURROUGHS D 201
2.8	-	TARGET INTERCEPT
2.18	MC	IBM 7080
2.18	MC	IBM 7090
3	MC	LINCOLN TX 0
3	MC	NAREC
3	MC	RCA 300
3 - 4	MC	NORDEN VOTE TALLY
4	MC	IBM 7074
4	MC	LITTON C 7000
4	MC	SYLVANIA S 9400
4	MC	UNIVAC LARC
4.5/Alphanum	MC	IBM 1410
4.8	MC	CDC 1604
5	MC	BURROUGHS D 103
5	MC	PROGRAMMED DATA PROCESSOR
5	MC	SYLVANIA UDOFTT
6	MC	AN/FSQ 7 AN/FSQ 8 (SAGE)
6	MC	IBM 7070
6	MC	ITT BANK IN PROC
6	MC	LITTON DATA ASSESSOR
6	CRT	MERLIN
6/Alphanum	MC	NATIONAL 304
6	MC	NATIONAL 315
6.4	MC	CDC 160
7	MC	RCA 301
7	MC	WHIRLWIND II
7.5	MC	GEORGE
8	MC	AN/TYK 7v INFORMER
8	MC	AN/USQ 20
8	MC	GENERAL MILLS AD/ECS

TABLE VI (CONTINUED)

ACCESS TIME OF HIGH SPEED STORAGE UNITS

ACCESS TIME MICROSECONDS	STORAGE MEDIUM	SYSTEM
8	MC	ITT SPES 025
8	MC	LEPRECHAUN
8	MC	MOBIDIC A
8	MC	MOBIDIC B
8	MC	MOBIDIC C D & 7A
8	CRT	NORC
8	CRT	OKLAHOMA UNIVERSITY
8	CRT	SWAC
8	MC	UNIVAC 1103 1103 A
8	MC	UNIVAC 1105
8 to 16	CRT	MANIAC I
8.4	MC	BENDIX G 20
9.3	MC	IBM 705 III
10	MC	GENERAL MILLS APSAC
10	MC	INTELEX AIRLINE RESERVATION
10	MC	LIBRASCOPE AIR TRAFFIC
10	MC	NUMERICORD
10	CRT	RICE UNIVERSITY
10	MC	RW 400
10	DL	TRICE
10	MC	UNIVAC 1101
10	MC	UNIVERSAL DATA TRANS
10/Bit	-	CUBIC TRACKER
11.5	MC	IBM 1401
12	MC	AN/TYK 6v BASICPAC
12	MC	COMPAC
12	MC	DATAMATIC 1000
12	MC	IBM 701
12	MC	IBM 704
12	MC	IBM 709
12	MC	LINCOLN CG 24
12	MC	PHILCO 1000
12	MC	PHILCO CXPQ
12 and 216	CRT and DL	SEAC
14	MC	SCRIBE
15	MC	BURROUGHS 220
15	MC	JOHNNIAC
15	MC	ORDVAC
15	MC	RCA 501
16	MC	TELEREGISTER TELEFILE
17	MC	IBM 702
17	MC	IBM 705 I II
18	CRT	ORACLE
18 - 36	CRT	ILLIAC
20	MC	BIZMAC I
20	MC	BIZMAC II
20	MC	DIGITRONIC CONVERTER
20	MC	GENERAL ELECTRIC 225

TABLE VI (CONTINUED)

ACCESS TIME OF HIGH SPEED STORAGE UNITS

ACCESS TIME MICROSECONDS	STORAGE MEDIUM	SYSTEM
20	MC	HONEYWELL 290
20	MC	IBM 1620
20	MC	LIBRASCOPE MK 130
20 and 20	CRT and MC	MISTIC
21.5	MC	IBM 632
22	DL	STORED PROGRAM DDA
22/Bit	MC	NATIONAL 390
24	MC	AN/ASQ 28 (v) MDC
30	CRT	CYCLONE
32	MC	GE 100 ERMA
32	MC	GENERAL ELECTRIC 210
34	MC	DIANA
40	MC	ATHENA
40	MC	UNIVAC II
40.4 to 404	DL	UNIVAC I
48 - 384	DL	DYSEAC
48 - 384	DL	EDVAC
84	MC	HUGHES D PAT
88	MC	UDEC I II III
96 - 129	VT	LOGISTICS
208	DL	SPEC
220	MC	IBM 608
250 - 500	DL	CCC REAL TIME
288	MC	MODAC 414
500	MC	ALWAC III E
500	VT	IBM 604
520	VT	IBM 607
625	MC	HUGHES BM GUIDANCE
760	VT	IBM CPC
900	MC	UNIVAC FILE 1
3,000	MC	BURROUGHS D 104

KEY TO SYMBOLS

CRT Cathode Ray Tube (Electrostatic)
MC Magnetic Core (Static Magnetic)
DL Delay Line (Sonic, Electric, Magnetostrictive)
VT Vacuum Tube
TF Thin Magnetic Film

TABLE VII

CAPACITY OF HIGH SPEED STORAGE UNITS

CAPACITY WORDS - DIGITS/WORD	STORAGE MEDIUM	SYSTEM
16,384 to 262,144 - 64 Bin	MC	IBM STRETCH
81,920 to 163,840 - 50 Bin	MC	AN/FSQ 32
65,536 to 131,072 - 50 Bin	MC	AN/FSQ 31 (v)
97,500 - 12 Dec	MC	UNIVAC LARC
69,632 - 38 Bin	MC	LINCOLN TX 2
65,536 and 128 - 36 Bin	MC and TF	UNIVAC 1107
69,632 - 32 Bin	MC	AN/FSQ 7 AN/FSQ 8 (SAGE)
up to 262,144 Alphanumeric Char	MC	RCA 501
4,096 to 32,768 - 48 Bin	MC	PHILCO 2000
32,768 - 48 Bin	MC	CDC 1604
262,144 - 6 Bin (Var)	MC	RCA 601
up to 32,000 - 12 Dec	MC	HONEYWELL 800
32,768 - 38 Bin	MC	SYLVANIA S 9400
32,768 - 36 Bin	MC	IBM 7090
up to 32,768 - 36 Bin	MC	IBM 704
4,096 to 32,768 - 36 Bin	MC	IBM 709
65,536 - 18 Bin	MC	LINCOLN TX 0
20,000 - 16 Dec	CRT	NORC
4,096 - 32,768 - 33 Bin	MC	BENDIX G 20
32,768 - 30 Bin	MC	AN/USQ 20
16,384 to 32,768 - 30 Bin	MC	UNIVAC 490
40,000 to 160,000 Alphanumeric Char	MC	IBM 7080
16,384 - 49 Bin	MC and CRT	MANIAC II
16,384 - 48 Bin	MC	NAREC
32,768 - 24 Bin	MC	UNIVAC III
1,024 and 16,384 - 40 Bin	CRT and MC	MISTIC
16,384 - 34 Bin	MC	BURROUGHS D 107
16,384 - 33 Bin	MC	ITT SPES 025
8,192 - 63 Bin	CRT	OKLAHOMA UNIVERSITY
40,000 or 80,000 Alphanumeric Char	MC	IBM 705 III
8,192 - 54 Bin	CRT	RICE UNIVERSITY
12,288 - 36 Bin	MC	UNIVAC 1103 1103 A
4,096 to 12,288 - 36 Bin	MC	UNIVAC 1105
2,000 to 40,000 - 3 Dec	MC	NATIONAL 315
8,192 - 49 Bin	CRT	MERLIN
8,192 - 48 Bin	-	MANIAC III
to 16,384 - 22 Bin	MC	PACKARD BELL 250
10,000 - 10 Dec	MC	BURROUGHS 220
2,000 to 10,000 - 10 Dec	MC	INTELEX AIRLINE RESERVATION
5,000 or 9,990 - 10 Dec	MC	IBM 7070
5,000 or 9,990 - 10 Dec	MC	IBM 7074
2,048 to 16,384 - 20 Bin	MC	GENERAL ELECTRIC 225

TABLE VII (CONTINUED)

CAPACITY OF HIGH SPEED STORAGE UNITS

CAPACITY WORDS - DIGITS/WORD	STORAGE MEDIUM	SYSTEM
8,192 - 40 Bin	MC	MOBIDIC A
8,192 - 40 Bin	MC	MOBIDIC B
8,192 - 40 Bin	MC	MOBIDIC C D & 7A
12,236 and 15 - 25 and 14 Bin	-	TARGET INTERCEPT
4,096 - 72 Bin	MC	BRLESC
2,400 to 4,800 - 10 Alphanum	MC	NATIONAL 304
40,000 Alphanumeric Char	MC	IBM 705 I II
40,000 Alphanumeric Char	MC	IBM 1410
8,192 - 27 Bin	MC	LINCOLN CG 24
4,096 - 52 Bin	MC	CDC 160
20,000 to 60,000 Decimal Digits	MC	IBM 1620
4,096 - 48 Bin	MC	PHILCO CXPQ
8,189 - 22 Bin	MC	SYLVANIA UDOFTT
4,096 - 42 Bin	MC	GEORGE
4,096 - 40 Bin	MC	JOHNNIAC
4,096 - 40 Bin	MC	ORDVAC
4,000 or 8,000 - 6 Dec	MC	GENERAL ELECTRIC 210
4,096 - 38 Bin	MC	AN/TYK 6v BASICPAC
4,096 - 38 Bin	MC	AN/TYK 7v INFORMER
4,096 - 38 Bin	MC	COMPAC
4,096 - 37 Bin	MC	GENERAL MILLS AD/ECS
4,096 - 18 or 36 Bin	MC	IBM 701
4,096 - 36 Bin	MC	PHILCO 1000
20,000 Alphanumeric Char	MC	RCA 301
4,096 and 1,024 - 21 and 24 Bin	MC	WESTINGHOUSE AIRBORNE
4,000 - 8 Dec	MC	LIBRASCOPE AIR TRAFFIC
8,192 - 13 Bin	MC	RCA 300
256 to 4,096 - 24 Bin	MC	RCA 110
4,096 - 24 Bin	MC	UNIVAC 1101
6,144 - 16 Bin	MC	WHIRLWIND II
1,400 - 16,000 Alphanumeric Char	MC	IBM 1401
4,000 - 7 Dec	MC	GE 100 ERMA
2,048 - 45 Bin	CRT and DL	SEAC
2,048 - 40 Bin	CRT	ORACLE
2,000 - 12 Dec	MC	DATAMATIC 1000
2,000 - 12 Dec	MC	UNIVAC II
4,096 - 19 Bin	MC	LIBRASCOPE MK 130
1,024 to 4,096 - 18 Bin	MC	HONEYWELL 290
1,024 or 4,096 - 18 Bin	MC	PROGRAMMED DATA PROCESSOR
2,048 - 36 Bin	MC	UNIVERSAL DATA TRANS
10,000 Alphanumeric Char	MC	IBM 702
15,000 Decimal Digits	MC	TELEREGISTER TELEFILE

TABLE VII (CONTINUED)

CAPACITY OF HIGH SPEED STORAGE UNITS

CAPACITY WORDS - DIGITS/WORD	STORAGE MEDIUM	SYSTEM
8,192 Alphanumeric Char	MC	BIZMAC II
256 and 1,536 - 29 and 27 Bin	MC	BURROUGHS D 204
1,024 - 44 Bin	DL	EDVAC
1,024 - 40 Bin	CRT	CYCLONE
1,024 - 40 Bin	CRT	ILLIAC
1,024 - 40 Bin	CRT	MANIAC I
1,000 - 12 Dec	DL	UNIVAC I
200 to 10,000 Decimal Digits	MC	DIANA
1,024 - 32 Bin	MC	LITTON DATA ASSESSOR
1,280 - 22 Bin	MC	LITTON C 7000
4,096 Alphanumeric Char	MC	BIZMAC I
512 - 46 Bin	DL	DYSEAC
1,024 - 23 Bin	MC	AN/ASQ 28 (v) MDC
512 - 36 Bin	MC	GENERAL MILLS APSAC
1,024 - 18 Bin	MC	LEPRECHAUN
512 - 32 Bin	MC	BURROUGHS D 104
256 and 512 - 24 and 16 Bin	MC	BURROUGHS D 208
512 - 22 Bin	MC	BURROUGHS D 202
600 - 17 Bin	MC	NORDEN VOTE TALLY
600 - 17 Bin	MC	SCRIBE
256 - 39 Bin	CRT	SWAC
200 - 12 Dec	MC	NATIONAL 390
320 - 25 Bin	DL	CCC REAL TIME
256 - 24 Bin	MC	ATHENA
1,024 - 6 Bin	MC	DIGITRONIC CONVERTER
100 - 12 Dec	MC	ITT BANK IN PROC
100 - 10 Dec	MC	UDEC I II III
219 - 15 Bin	DL	STORED PROGRAM DDA
77 - 12 Dec	DL	RPC 9000
128 - 21 Bin	MC	BURROUGHS D 201
128 and 20 - 13 and 21 Bin	DL	SPEC
20 - 12 Alphanum	MC	UNIVAC FILE 1
32 - 12 Dec	MC	IBM 609
81 - 16 Bin	MC	BURROUGHS D 209
64 - 8 to 20 Bin	-	CUBIC TRACKER
40 - 9 Dec	MC	IBM 608
334 Decimal Digits	MC	NUMERICORD
32 - 33 Bin	MC	ALWAC III E
15 - 12 Dec	VT	LOGISTICS
12 - 10 Dec	VT	UNIVAC 120
20 - 20 Bin	MC	BURROUGHS D 103

TABLE VII (CONTINUED)

CAPACITY OF HIGH SPEED STORAGE UNITS

CAPACITY WORDS - DIGITS/WORD	STORAGE MEDIUM	SYSTEM
15 - 22 Bin	MC	HAMPSHIRE TRTDS 932
8 - 12 Dec	MC	IBM 632
16 - 20 Bin	MC	RCA 200
9 - 22 Bin	MC	HAMPSHIRE CCC 500
9 - 3 or 5 Dec	VT	IBM 604
9 - 3 or 5 Dec	VT	IBM CPC
37 Decimal Digits	VT	IBM 607
3 - 19 Bin	MC	HUGHES D PAT
2 - 6 Dec	MC	MODAC 414
1 - 27 Bin/Module	DL	TRICE
Var - 7 Dec	MC	RW 400

KEY TO SYMBOLS

CRT	Cathode Ray Tube (Electrostatic)
MC	Magnetic Core (Static Magnetic)
DL	Delay Line (Sonic, Electric, Magnetostrictive)
VT	Vacuum Tube
TF	Thin Film

TABLE VIII

LOG_{10} CAPACITY/ACCESS TIME OF HIGH SPEED STORAGE UNITS

LOG_{10} CAPACITY/ACCESS	STORAGE MEDIUM	SYSTEM
13.527	MC	IBM STRETCH
12.515	MC	AN/FSQ 32
12.418	MC	AN/FSQ 31 (v)
12.242	MC	RCA 601
12.134	CRT	NORC
12.118	MC	UNIVAC 1107
12.054	MC	LINCOLN TX 2
11.997	MC	UNIVAC LARC
11.896	MC	PHILCO 2000
11.867	MC	UNIVAC III
11.794	MC	HONEYWELL 800
11.733	MC	IBM 7090
11.713	MC	UNIVAC 490
11.644	MC	IBM 7080
11.633	MC	WESTINGHOUSE AIRBORNE
11.594	MC	LINCOLN TX 0
11.594	-	MANIAC III
11.569	MC	AN/FSQ 7 AN/FSQ 8 (SAGE)
11.418	MC	NAREC
11.168	MC	BRLESC
11.109	MC	BENDIX G 20
11.090	MC	AN/USQ 20
11.040	-	TARGET INTERCEPT
11.021	MC	RCA 501
10.992	MC	IBM 709
10.983	MC	IBM 704
10.922	MC	MANIAC II
10.875	MC	IBM 7074
10.833	MC	NATIONAL 315
10.830	MC	ITT SPES 025
10.824	CRT	MERLIN
10.809	CRT	OKLAHOMA UNIVERSITY
10.766	MC	IBM 7070
10.742	MC	UNIVAC 1103 1103 A
10.742	MC	UNIVAC 1105
10.727	MC	IBM 1410
10.713	MC	IBM 705 III
10.681	MC	NATIONAL 304
10.646	CRT	RICE UNIVERSITY
10.614	MC	BURROUGHS D 107
10.611	MC	MOBIDIC A
10.611	MC	MOBIDIC B
10.611	MC	MOBIDIC C D & 7A
10.556	MC	SYLVANIA UDOFTT
10.550	MC	RCA 300

TABLE VIII (CONTINUED)

LOG_{10} CAPACITY/ACCESS TIME OF HIGH SPEED STORAGE UNITS

LOG_{10} CAPACITY/ACCESS	STORAGE MEDIUM	SYSTEM
10.542	CRT and MC	MISTIC
10.532	MC	INTELEX AIRLINE RESERVATION
10.521	MC	CDC 160
10.516	MC	CDC 1604
10.493	MC	SYLVANIA S 9400
10.474	MC	GE 100 ERMA
10.360	MC	GEORGE
10.356	MC	BURROUGHS 220
10.289	MC	AN/TYK 7v INFORMER
10.278	MC	GENERAL MILLS AD/ECS
10.266	MC	LINCOLN CG 24
10.234	MC	RCA 301
10.215	MC	GENERAL ELECTRIC 225
10.214	MC	PHILCO CXPQ
10.168	MC	PROGRAMMED DATA PROCESSOR
10.150	MC	IBM 705 I II
10.146	MC	WHIRLWIND II
10.122	MC	AN/TYK 6v BASICPAC
10.113	MC	COMPAC
10.090	MC	PHILCO 1000
10.088	MC	IBM 701
10.038	MC	JOHNNIAC
10.038	MC	ORDVAC
10.037	MC	LIBRASCOPE AIR TRAFFIC
10.008	MC	IBM 1620
9.992	MC	UNIVAC 1101
9.922	MC	IBM 1401
9.868	MC	UNIVERSAL DATA TRANS
9.855	MC	BURROUGHS D 208
9.846	MC	LITTON C 7000
9.832	MC	DATAMATIC 1000
9.750	MC	BURROUGHS D 202
9.736	MC	LITTON DATA ASSESSOR
9.710	CRT	MANIAC I
9.708	MC	GENERAL ELECTRIC 210
9.658	CRT	ORACLE
9.590	MC	LIBRASCOPE MK 130
9.584	CRT	SEAC
9.566	MC	HONEYWELL 290
9.553	DL	RPC 9000
9.548	MC	IBM 702
9.531	MC	NORDEN VOTE TALLY
9.504	MC	TELEREGISTER TELEFILE
9.390	MC	BIZMAC II
9.364	MC	LEPRECHAUN
9.356	CRT	ILLIAC
9.310	MC	UNIVAC II
9.265	MC	GENERAL MILLS APSAC

TABLE VIII (CONTINUED)

LOG_{10} CAPACITY/ACCESS TIME OF HIGH SPEED STORAGE UNITS

LOG_{10} CAPACITY/ACCESS	STORAGE MEDIUM	SYSTEM
9.135	CRT	CYCLONE
9.097	CRT	SWAC
9.090	MC	BIZMAC I
9.032	MC	BURROUGHS D 201
9.004	DL	UNIVAC I
9.000	MC	DIANA
8.992	MC	AN/ASQ 28 (v) MDC
8.973	DL	EDVAC
8.844	MC	ITT BANK LN PROC
8.728	MC	SCRIBE
8.709	DL	DYSEAC
8.570	MC	NATIONAL 390
8.487	MC	DIGITRONIC CONVERTER
8.186	MC	ATHENA
8.184	DL	STORED PROGRAM DDA
8.056	MC	NUMERICORD
7.904	MC	BURROUGHS D 103
7.587	MC	UDEC I II III
7.204	DL	CCC REAL TIME
7.183	MC	IBM 632
7.000	DL	SPEC
6.806	-	CUBIC TRACKER
6.805	VT	LOGISTICS
6.746	MC	IBM 608
6.738	MC	BURROUGHS D 104
6.431/Module	DL	TRICE
6.324	MC	ALWAC III E
6.284	VT	IBM 607
6.204	MC	UNIVAC FILE 1
5.832	MC	HUGHES D PAT
5.401	VT	IBM 604
5.218	VT	IBM CPC
5.154	MC	MODAC 414

KEY TO SYMBOLS

CRT	Cathode Ray Tube (Electrostatic)
MC	Magnetic Core (Static Magnetic)
DL	Delay Line (Sonic, Electric, Magnetostrictive)
VT	Vacuum Tube

TABLE IX

CAPACITY OF MAGNETIC DRUM OR DISC STORAGE UNITS

CAPACITY WORDS - DIGITS/WORD	SYSTEM
2,097,152 to 67,108,864 - 64 Bin	IBM STRETCH
652,000,000 Alphanum Char	DIANA
72,000,000 - 12 Dec	UNIVAC LARC
24,050,000 - 10 Dec	UNIVAC SOLID STATE 80/90
23,040,000 - 10 Dec	UNIVAC STEP
6,500,000 - 36 Bin	UNIVAC 1107
6,000,000 - 38 Bin	SYLVANIA S 9400
62,000,000 Decimal Digits	RASTAC
62,000,000 Decimal Digits	RASTAD
600,000 to 4,800,000 - 10 Dec	IBM 7070
600,000 to 4,800,000 - 10 Dec	IBM 7074
3,750,000 - 38 Bin	AN/TYK 7v INFORMER
20,000,000 Alphanum Char	IBM 305 RAMAC
20,000,000 Alphanum Char	IBM 1401
10,000,000 to 20,000,000 Alphanum Char	IBM 1410
24,000,000 Decimal Digits	UNIVAC III
32,768 to 1,048,576 - 48 Bin	PHILCO 2000
6,250,000 - 8 Bin	MOBIDIC B
6,000,000 Alphanum Char	IBM 705 III
1,114,112 - 30 Bin	UNIVAC 490
139,264 to 557,056 - 50 Bin	AN/FSQ 31 (v)
139,264 to 557,056 - 50 Bin	AN/FSQ 32
21,000 to 117,000 - 4 to 60 Dec	LOGISTICS
600,000 - 10 Dec/Unit	IBM 650 RAMAC TAPES
1,070 to 151,070 - 12 Alphanum Char	UNIVAC FILE 0
1,070 to 151,070 - 12 Alphanum Char	UNIVAC FILE 1
256,000 - 8 Dec	LIBRASCOPE AIR TRAFFIC
135,168 - 32 Bin	AN/FSQ 7 AN/FSQ 8 (SAGE)
65,536 - 33 Bin	ITT SPES 025
20,010 - 96 Bin	MONROBOT MU
24,576 - 72 Bin	BRLESC
1,500,000 Binary Digits	TELEREGISTER MAGNETRONIC INVENTORY CONTROL
1,300,000 Binary Digits	TELEREGISTER UNIFIED AIRLINE
4,096 to 51,200 - 24 Bin	RCA 110
8,500 - 42 Dec	MAGNEFILE D
16,384 to 32,768 - 36 Bin	UNIVAC 1105
2,048 to 50,000 - 20 Bin	GENERAL ELECTRIC 312
16,384 - 48 Bin	PHILCO CXPQ
40,728 - 19 Bin	HUGHES D PAT
8,192 or 16,384 - 18 or 36 Bin	IBM 701
16,384 - 36 Bin	IBM 704
8,192 or 16,384 - 36 Bin	IBM 709
16,384 - 36 Bin	UNIVAC 1103, 1103 A
36,864 - 16 Bin	WHIRLWIND II
26,624 and 6,656 - 16 and 24 Bin	AN/ASQ 28 (v) MDC

TABLE IX (CONTINUED)

CAPACITY OF MAGNETIC DRUM OR DISC STORAGE UNITS

CAPACITY WORDS - DIGITS/WORD	SYSTEM
4,096 to 32,000 - 18 Bin	HONEYWELL 290
12,800 - 40 Bin	ILLIAC
12,288 - 40 Bin	JOHNNIAC
12,800 - 10 Dec	INTELEX AIRLINE RESERVATION
11,000 - 11 Dec	NATIONAL 107
10,000 - 12 Dec	ITT BANK IN PROC
20,000 - 6 Dec	MODAC 404
10,032 - 40 Bin	ORDVAC
10,000 - 40 Bin	MANIAC I
8,192 - 48 Bin	NAREC
16,384 - 24 Bin	UNIVAC 1101
10,000 - 11 Dec	OARAC
10,000 - 37 Bin	GENERAL MILLS AD/ECS
3,770 - 96 Bin	BURROUGHS D 103
60,000 Alphanum Char	IBM 702
60,000 Alphanum Char	IBM 705 I II
16,260 - 22 Bin	LEEDS NORTHROP 3000
8,064 to 16,256 - 22 Bin	PHILCO 3000
4,000 to 10,000 - 10 Dec	ELECOM 125 125FP
8,192 or 16 [illegible] - 20 Bin	GENERAL ELECTRIC 225
8,[illegible] - 38 Bin	SWAC
12,[illegible]0 - 22 Bin	LITTON C 7000
7,936 t[illegible] 15,[illegible]20 - 18 Bin	RW 300
[illegible],320 - 33 Bin	ALWAC III E
1,000 to 10,000 - 8 Dec	ELECOM 120
12,256 - 22 Bin	BURROUGHS D 202
8,064 - 32 Bin	LIBRATROL 1000
8,008 - 32 Bin	RPC 4000
4,608 - 44 Bin	EDVAC
10,000 - 20 Bin	MODAC 5014
8,192 - 24 Bin	UNIVAC 1102
32,736 Alphanum Char	BIZMAC II
4,096 - 46 Bin	CIRCLE
5,300 - 10 Dec	UDEC I II III
5,000 - 10 Dec	MODAC 410
4,096 - 41 Bin	AN/MJQ 1 REDSTONE
4,096 - 41 Bin	JUKEBOX
4,096 - 12 Dec	REPAC
4,096 - 40 Bin	RECOMP II
5,014 - 32 Bin	BURROUGHS D 203
4,128 - 35 Bin	FADAC
4,160 - 10 Dec	READIX
4,096 - 10 Dec	MINIAC II
8,192 - 17 Bin	ATHENA
4,080 - 10 Dec	BURROUGHS 204
4,080 - 10 Dec	BURROUGHS 205

TABLE IX (CONTINUED)

CAPACITY OF MAGNETIC DRUM OR DISC STORAGE UNITS

CAPACITY WORDS - DIGITS/WORD	SYSTEM
4,096 - 32 Bin	LGP 30
4,160 - 31 Bin	LIBRATROL 500
6,004 - 6 Dec	MODAC 414
6,784 - 18 Bin	LIBRASCOPE MK 38
4,040 - 8 Dec	MAGNEFILE B
5,225 - 21 Bin	BURROUGHS D 201
18,000 Alphanum Char	BIZMAC I
10,000 - 3 Dec	AMOS IV
100,000 Binary Digits	TELEREGISTER MAGNETRONIC BID ASKED
3,840 - 26 Bin	AN/ASQ 28 (v) EDC
99,584 Binary Digits	ASG 15
2,048 - 48 Bin	BURROUGHS D 104
2,500 - 11 Dec	PENNSTAC
2,064 - 40 Bin	RECOMP I CP 266
2,560 - 32 Bin	LITTON DATA ASSESSOR
22,000 Decimal Digits	AF/CRC
2,112 - 33 Bin	ALWAC II
3,000 - 22 Bin	LIBRASCOPE 407
2,560 - 25 Bin	LIBRASCOPE ASN 24
2,176 - 29 Bin	BENDIX G 15
1,031 - 50 Bin	WISC
1,024 - 42 Bin	NATIONAL 102 A
1,664 - 24 Bin	VERDAN
1,024 - 9 Dec + 6 Bin	NATIONAL 102 D
1,992 - 17 Bin	HUGHES ADV AIRBORNE III
1,024 - 32 Bin	MONROBOT XI
784 - 40 Bin	SCRIBE
1,025 - 20 Bin	CUBIC AIR TRAFFIC
300 - 20 Dec	MONROBOT V
650 - 8 Dec	BENDIX D 12
1,024 - 16 Bin	HRB SINGER
512 - 30 Bin	ELECOM 100
200 - 20 Dec	MONROBOT III
200 - 20 Dec	MONROBOT VI
32 to 160 - 18 Dec	DE 60
220 - 12 Dec	BURROUGHS E 101
220 - 12 Dec	BURROUGHS E 102
220 - 12 Dec	BURROUGHS E 103
84 - 31 Dec	IBM 610
100 - 10 Dec	ELECOM 50
114 - 29 Bin	BENDIX CUBIC TRACKER
15 - 18 Dec	MONROBOT IX
Variable	RW 400
Variable	TELEREGISTER TELEFILE

TABLE X

TUBE QUANTITY IN COMPUTING SYSTEMS

TUBE QUANTITY	SYSTEM
5	PERK I II
6	BURROUGHS D 201
10 to 30	MONROBOT XI
13	RW 300
14	DE 60
15	AF/CRC
22	NORDEN VOTE TALLY
28	LINCOLN CG 24
48	PHILCO CXPQ
65	HAMPSHIRE TRTDS 932
74	MONROBOT IX
113	LGP 30
130	MAGNEFILE B
140	MAGNEFILE D
150	DISTRIBUTAPE
150	IBM 632
150	RASTAC
150	RASTAD
160	BURROUGHS E 101
160	BURROUGHS E 102
160	ELECOM 50
164	HAMPSHIRE CCC 500
175	LIBRATROL 500
215	UNIVAC SOLID STATE AD/90
215	UNIVAC STEP
230	ELECOM 100
240	BENDIX G 20
250	ALWAC II
250	BURROUGHS E 103
263	READIX
302	LIBRASCOPE CP 209
400	ELECOM 120
400	NATIONAL 102 A
409	HUGHES DIGITAIR
425	NATIONAL 102 D
440	LINCOLN TX 0
450	ELECOM 125 125 FP
450	PHILCO 2000
481	HUGHES ADV AIRBORNE III
535	MODAC 5014
600	MODAC 410
600	NUMERICORD
700	BENDIX D 12
765	LINCOLN TX 2
780	ALWAC III E
800	MONROBOT III
800	MONROBOT V
800	NATIONAL 107
800 - 1,000	CIRCLE
835	BENDIX G 15
850	MINIAC II
900	DYSEAC
1,000	MODAC 404
1,200	FOSDIC
1,200	OARAC
1,202	BURROUGHS 204
1,202	BURROUGHS 205
1,250	IBM 604
1,300	DIANA
1,300	NAREC
1,342	PENNSTAC
1,376 - 5,467	IBM 650 RAMAC TAPES
1,500	IBM CPC
1,800	BURROUGHS 220
1,800	SYLVANIA UDOFTT
1,800	WISC
2,000	MODAC 414
2,000	OKLAHOMA UNIV
2,044	IBM 305 RAMAC
2,148	UNIVAC 60
2,200	BURROUGHS D 103
2,281	SEAC
2,396	CYCLONE
2,400	MANIAC I
2,500	SWAC
2,584	IBM 607
2,610	MISTIC
2,695	UNIVAC 1101
2,700	UNIVAC 1102
2,942	MERLIN
3,000	UDEC I II III
3,430	ORDVAC

TABLE X (CONTINUED)

TUBE QUANTITY IN COMPUTING SYSTEMS

TUBE QUANTITY	SYSTEM	TUBE QUANTITY	SYSTEM
3,500	GEORGE	5,190	MANIAC II
3,556	RICE UNIVERSITY	5,200	UNIVAC I
3,600	DATAMATIC 1000	5,200	UNIVAC II
3,907	UNIVAC 1103 1103 A	5,937	EDVAC
4,000	IBM 701	6,120	BRLESC
4,427	ILLIAC	7,000	BURROUGHS D 104
4,500	LOGISTICS	8,293	UNIVAC 1105
4,500	TELEREGISTER UNIFIED AIRLINE	9,800	NORC
5,000	BIZMAC II	10,000	IBM 702
5,000	IBM 704	14,500	WHIRLWIND II
5,000	JOHNNIAC	30,000	BIZMAC I
5,000	ORACLE	50,000	AN/FSQ 7 AN/FSQ 8 (SAGE)

TABLE XI

CRYSTAL DIODE QUANTITY IN COMPUTING SYSTEMS

CRYSTAL DIODE QUANTITY	SYSTEM
1	MONROBOT V
40	MAGNEFILE B
100	MONROBOT III
115	PHILCO CXPQ
150	MODAC 5014
164	IBM 632
200	ORACLE
240	MAGNEFILE D
300	LEPRECHAUN
300	RCA 200
350	WISC
350	LINCOLN TX 0
406	IBM 305 RAMAC
500	JOHNNIAC
500	MANIAC I
886	STORED PROGRAM DDA
915	ORDVAC
950	AN/TYK 6v BASICPAC
1,000	HAMPSHIRE CCC 500
1,000	MONROBOT IX
1,113	IBM 1620
1,200	PHILCO 2000
1,250	CUBIC TRACKER
1,344	TARGET INTERCEPT
1,450	LIBRATROL 500
1,500	LGP 30
1,500	LIBRASCOPE AIR TRAFFIC
1,617	SPEC
1,626	BURROUGHS D 209
1,800	BURROUGHS E 101
1,800	BURROUGHS E 102
1,964	DISTRIBUTAPE
2,000	BURROUGHS E 103
2,000	CUBIC AIR TRAFFIC
2,000	DE 60
2,000	ELECOM 50
2,000	FOSDIC
2,000	MINIAC II
2,000	MODAC 404
2,000	SYLVANIA S 9400
2,200	BENDIX D 12
2,200	ELECOM 100
2,265	GENERAL ELECTRIC 312
2,292	RCA 300
2,300	MONROBOT XI
2,400	LIBRATROL 1000
2,500	ELECOM 125 125FP
2,500	NATIONAL 107
2,385	UNIVAC 1101
3,000	HAMPSHIRE TRIDS 932
3,000	LEEDS NORTHROP 3000
3,000	MODAC 410
3,000	MODAC 414
3,000	PROGRAMMED DATA PROCESSOR
3,000	TELEREGISTER UNIFIED AIRLINE
3,000	UNIVAC 1102
3,050	MANIAC II
3,364	HUGHES ADV AIRBORNE III
3,500	ALWAC II
3,500	COMPAC
3,553	LIBRASCOPE ASN 24
3,800	BURROUGHS 204
3,800	BURROUGHS 205
3,943 - 11,428	IBM 650 RAMAC TAPES
4,000	HUGHES M 252
4,000	NATIONAL 390
4,000	RW 300
4,000	SWAC
4,075	READIX
4,200	PHILCO 3000
4,289	HUGHES DIGITAIR
4,395	AN/ASQ 28 (v) EDC
4,400	BENDIX G 15
4,500	ELECOM 120
Over 4,500	LIBRASCOPE CP 209
4,700	NORDEN VOTE TALLY
5,000	LOGISTICS
5,000	NUMERICORD
5,000	SCRIBE
5,194	IBM 609

TABLE XI (CONTINUED)

CRYSTAL DIODE QUANTITY IN COMPUTING SYSTEMS

CRYSTAL DIODE QUANTITY	SYSTEM
5,194	IBM 609
5,200	BURROUGHS D 201
5,224	LINCOLN TX 2
5,316	JUKEBOX
5,400	HUGHES D PAT
5,768	PENNSTAC
6,000	GEORGE
6,000	MOBIDIC A
6,000	MOBIDIC B
6,000	MOBIDIC C D 7A
6,000	UDEC I II III
6,213 - 14,171	IBM 1401
6,314	AN/TYK 7v INFORMER
6,900	BURROUGHS D 203
7,000	BURROUGHS D 208
7,000	CDC 160
7,000	OARAC
7,000	RECOMP I CP 266
8,000	NATIONAL 102 A
8,000	NATIONAL 304
8,000	RASTAC
8,000	RASTAD
8,500	NATIONAL 102 D
8,956	UNIVAC 1103 1103 A
9,000	HONEYWELL 290
10,000	IBM 704
10,000	RECOMP II
10,000	VERDAN
11,090	BURROUGHS D 204
12,000	BURROUGHS D 202
12,000	EDVAC
12,000	REPAC
12,800	IBM 701
13,000	RICE UNIVERSITY
13,076	AN/ASQ 28 (v) MDC
13,160	BURROUGHS D 107
13,500	ALWAC III E
14,000	BURROUGHS D 103
14,000	WHIRLWIND II
14,500	BIZMAC II
14,515	LIBRASCOPE MK 130
15,000	GENERAL MILLS AD/ECS
15,500	TELEREGISTER TELEFILE
15,651	LIBRASCOPE MK 38
15,985	WESTINGHOUSE AIRBORNE
16,000	OKLAHOMA UNIV
16,415	UNIVAC 1105
16,540	MERLIN
17,000	IBM 702
18,000	UNIVAC I
18,000	UNIVAC II
20,000	GENERAL MILLS APSAC
20,000	MANIAC III
20,000	SYLVANIA UDOFTT
22,000	CCC REAL TIME
23,000	LITTON DATA ASSESSOR
24,000	SEAC
24,500	DYSEAC
25,000	BURROUGHS D 104
30,000	HONEYWELL 800
30,000	ITT BANK L. PROC
30,000	NAREC
30,000	NORC
33,000	ATHENA
33,200	LINCOLN CG 24
33,787	AN/USQ 20
36,505	UNIVAC SOLID STATE 80/90
36,505	UNIVAC STEP
38,000	BENDIX G 20
50,000	ITT SPEC 025
60,000	DATAMATIC 1000
62,000	DIANA
70,000	BIZMAC I
90,417	UNIVAC 1107
100,000	CDC 1604
126,300	BRLESC
170,000	AN/FSQ 7 AN/FSQ 8 (SAGE)
229,000	AN/FSQ 31 (v)
305,000	AN/FSQ 32

TABLE XII

TRANSISTOR QUANTITY IN COMPUTING SYSTEMS

TRANSISTOR QUANTITY	SYSTEM
0-211	IBM 650 RAMAC TAPES
6	PENNSTAC
16	BENDIX G 15
64	DISTRIBUTAPE
75	ALWAC III E
100	ORACLE
100	RASTAC
100	RASTAD
Over 100	LIBRASCOPE CP 209
200	BIZMAC I
200	DE 60
279	SPEC
300	NUMERICORD
309	STORED PROGRAM DDA
328	EDVAC
382	LIBRASCOPE ASN 24
383	MONROBOT XI
400	PACKARD BELL 250
500	DATAMATIC 1000
500	SYLVANIA UDOFTT
580	RW 300
592	AN/ASQ 28 (v) EDC
650	LIBRATROL 1000
700	BURROUGHS D 209
703	AN/FSQ 7
820	MERLIN
885	JUKEBOX
900	HAMPSHIRE TRTDS 932
919	UNIVAC SOLID STATE 80/90
919	UNIVAC STEP
1,100	HUGHES M 252
1,148	UNIVAC 1105
1,150	NATIONAL 390
1,160	MANIAC II
1,200	UNIVAC II
1,300	LEEDS NORTHROP 3000
1,400	CDC 160
1,500	GENERAL MILLS AD/ECS
1,500	GENERAL MILLS APSAC
1,500	HONEYWELL 290
1,500	PHILCO 3000
1,500	RCA 200
1,500	REPAC
1,500	VERDAN
1,600	CUBIC TRACKER
1,600	RECOMP I CP 266
1,683	HUGHES LRIX
1,697	AN/ASQ 28 (v) MDC
1,800	HUGHES D PAT
1,820	BURROUGHS D 208
1,887	IBM 609
1,900	RICE UNIVERSITY
2,000	RECOMP II
2,000 - 3,000	OKLAHOMA UNIV
2,091	ORDVAC
2,563	LIBRASCOPE MK 38
2,572	GENERAL ELECTRIC 312
2,600	CUBIC AIR TRAFFIC
2,700	CCC REAL TIME
2,700	PROGRAMMED DATA PROCESSOR
3,000	FOSDIC
3,088	IBM 1620
3,100	LITTON DATA ASSESSOR
3,470	BURROUGHS D 107
3,500	LINCOLN TX 0
3,500	SCRIBE
3,500	TELEREGISTER TELEFILE
3,900	NORDEN VOTE TALLY
4,000	NATIONAL 304
4,200	BURROUGHS D 104
4,315 - 9,805	IBM 1401
4,800	NAREC
5,000	BURROUGHS D 202
5,000	LEPRECHAUN
5,400	RCA 300
5,550	PHILCO CXPQ
6,000	HONEYWELL 800
6,500	BURROUGHS D 203
6,600	BURROUGHS D 201
7,015	LIBRASCOPE MK 130
7,500	ATHENA
7,597	WESTINGHOUSE AIRBORNE
8,500	BURROUGHS D 204
8,740	BRLESC
8,900	BENDIX G 20
10,000	COMPAC
10,000	ITT BANK IN PROC
10,000	LOGISTICS

TABLE XII (CONTINUED)

TRANSISTOR QUANTITY IN COMPUTING SYSTEMS

TRANSISTOR QUANTITY	SYSTEM
10,265	AN/USQ 20
10,789	AN/TYK 7v INFORMER
12,000	MANIAC III
14,188	AN/TYK 6v BASICPAC
18,930	LINCOLN CG 24
20,000	GEORGE
20,000	TARGET INTERCEPT
23,000	LIBRASCOPE AIR TRAFFIC
25,000	CDC 1604
25,522	UNIVAC 1107
30,000	MOBIDIC B

TRANSISTOR QUANTITY	SYSTEM
30,000	MOBIDIC C D 7A
32,000	MOBIDIC A
36,000	SYLVANIA S 9400
Over 36,000	IBM 7080
51,000	ITT SPES 025
56,000	PHILCO 2000
61,533	LINCOLN TX 2
138,000	AN/FSQ 31 (v)
200,000	IBM STRETCH
201,000	AN/FSQ 32

TABLE XIII

APPROXIMATE POWER REQUIREMENT OF COMPUTING SYSTEMS

POWER KILOWATTS	SYSTEM
0.010	HRB SINGER
0.020	RCA 200
0.029	STORED PROGRAM DDA
0.030	HUGHES BM GUIDANCE
0.060	SPEC
0.10	PACKARD BELL 250
0.13	LIBRASCOPE ASN 24
0.13	RCA 300
0.15	ASC 15
0.15	DE 60
0.16	LEPRECHAUN
0.20	RPC 9000
0.22	BURROUGHS D 208
0.25	AN/ASQ 28 (v) EDC
0.25	LIBRASCOPE 407
0.30	HUGHES D PAT
0.30	RECOMP I CP 266
0.31	AN/TYK 7v INFORMER
0.32	VERDAN
0.37	HUGHES M 252
0.40	CCC REAL TIME
0.50	JUKEBOX
0.50	RECOMP II
0.50	RW 300
0.60	LEEDS NORTHROP 3000
0.60	MAGNEFILE B
0.60	REPAC
0.67	MONROBOT IX
0.70	CDC 160
0.70	FADAC
0.70	PHILCO 3000
0.73	RPC 4000
0.75	IBM 632
0.80	AN/ASQ 28 (v) MDC
0.80	PROGRAMMED DATA PROCESSOR
0.85	HUGHES LRI X
0.85	MONROBOT XI
0.86	BURROUGHS D 203
0.86	GENERAL MILLS APSAC
0.90	BURROUGHS D 201
0.90	TRICE
0.95	LITTON C 7000
1.0	AN/MJQ 1 REDSTONE
1.0	BURROUGHS D 107
1.0	CUBIC TRACKER
1.0	GENERAL MILLS AD/ECS
1.0	GEOTECH AUTOMATIC
1.0	HAMPSHIRE CCC 500
1.0	IBM 609
1.0	MAGNEFILE D
1.1	LGP 30
1.2	PHILCO 1000
1.4	HONEYWELL 290
1.5	HAMPSHIRE TRTDS 932
1.5	HUGHES ADV AIRBORNE III
1.5	IBM 610
1.5	LITTON DATA ASSESSOR
1.8	BURROUGHS D 202
1.8	BURROUGHS E 103
1.8	LIBRASCOPE CF 209
1.8	WESTINGHOUSE AIRBORNE
1.8	BURROUGHS D 204
2.0	DISTRIBUTAPE
2.0	ELECOM 50
2.0	IBM 1620
2.0	LIBRATROL 1000
2.0	MANIAC III
2.1	IBM 608
2.5	AN/USQ 20
2.5	LIBRATROL 500
2.5	MONROBOT III
2.5	TARGET INTERCEPT
2.7	SCRIBE
2.9 - 12	IBM 1401
3.0	BURROUGHS E 101
3.0	BURROUGHS E 102
3.0	CIRCLE
3.0	LIBRASCOPE AIR TRAFFIC
3.0	MODAC 404
3.1	BENDIX G 20
3.5	BENDIX G 15
3.5	ELECOM 100
3.6	COMPAC
4.0	ALWAC II
4.0	GENERAL ELECTRIC 312
4.0	MODAC 410

TABLE XIII (CONTINUED)

APPROXIMATE POWER REQUIREMENT OF COMPUTING SYSTEMS

POWER KILOWATTS	SYSTEM	POWER KILOWATTS	SYSTEM
4.3	BENDIX CUBIC TRACKER	14	BURROUGHS 204
4.3	NATIONAL 390	14	BURROUGHS 205
4.5	LIBRASCOPE MK 38	14	IBM 7080
4.5	NORDEN VOTE TALLY	15	UNIVAC 1101
4.5	RCA 110	16	IBM 650 RAMAC TAPES
4.6	LINCOLN CG 24	17	IBM 7070
5.0	ALWAC III E	17	LOGISTICS
5.0	ELECOM 120	18	MISTIC
5.0	ELECOM 125 125FP	18	SYLVANIA S 9400
5.0	FOSDIC	19	CYCLONE
5.0	LIBRASCOPE MK 130	20	AN/TYK 6v BASICPAC
5.0	MINIAC II	20	LINCOLN TX 2
5.0	MODAC 414	20	RICE UNIVERSITY
5.0	MONROBOT V	21	OARAC
5.0	UNIVERSAL DATA TRANS	22	SEAC
5.5	ATHENA	22	UNIVAC 1102
5.6	RCA 501	24	SYLVANIA UDOFTT
5.8	IBM 7090	25	NAREC
6.0	ITT BANK LN PROC	26	IBM 7074
6.0	NUMERICORD	26	RCA 301
6.8	IBM 604	27	ILLIAC
7.2	PENNSTAC	29	BURROUGHS D 103
7.5	BENDIX D 12	30	BURROUGHS 220
7.5	CDC 1604	30	ITT SPES 025
7.7	NATIONAL 102 A	30	MOBIDIC A
7.7	NATIONAL 102 D	30	SWAC
8.0	READIX	30	UDEC I II III
8.0	UNIVAC 120	30	UNIVAC 1107
8.5	IBM CPC	31	UNIVAC 490
9.0	GENERAL ELECTRIC 210	32	HONEYWELL 800
9.0	PHILCO CXPQ	33	MANIAC II
10	LINCOLN TX 0	34	MOBIDIC B
10	RW 400	35	BRLESC
10	WISC	35	MANIAC I
11	IBM 305 RAMAC	37	BIZMAC II
12	DYSEAC	38	NATIONAL 304
12	IBM 607	39	UNIVAC SOLID STATE 80/90
12	OKLAHOMA UNIV	40	MERLIN
13	AF/CRC	40	ORDVAC
13	GENERAL ELECTRIC 225	45	MOBIDIC C D & 7A
13	RASTAC	45	PHILCO 2000
13	RASTAD	45	RCA 601
13	UNIVAC STEP	50	GEORGE

TABLE XIII (CONTINUED)

APPROXIMATE POWER REQUIREMENT OF COMPUTING SYSTEMS

POWER KILOWATTS	SYSTEM	POWER KILOWATTS	SYSTEM
52	EDVAC	95	DATAMATIC 1000
55	JOHNNIAC	100	IBM STRETCH
60	BURROUGHS D 104	107	AN/FSQ 32
69	IBM 705 I II	109	AN/FSQ 31 (v)
71	UNIVAC FILE 0	113	IBM 709
71	UNIVAC FILE 1	124	UNIVAC II
74	UNIVAC 1103 1103 A	131	IBM 705 III
75	IBM 702	150	GE 100 ERMA
75	ORACLE	160	UNIVAC 1105
75	UNIVAC III	167	UNIVAC LARC
76	IBM 701	168	NORC
76	IBM 704	180	WHIRLWIND II
81	UNIVAC I	246	BIZMAC I
90	DIANA	750	AN/FSQ 7 AN/FSQ 8 (SAGE)

TABLE XIV

APPROXIMATE COST OF COMPUTING SYSTEMS
(BASIC OR TYPICAL SYSTEM)

COST	SYSTEM	COST	SYSTEM
$ 1,000	PERK I II	$ 86,074	MONROBOT V
6,000	IBM 632	87,500	RPC 4000
9,650	MONROBOT IX	95,000	RECOMP II
15,000	HRB SINGER	97,000	ELECOM 120
17,000 to 20,000	ITT BANK LN PROC	97,500	UNIVAC 120
18,000	DE 60	98,000	RW 300
19,195	SPEC	100,000	MODAC 404
20,000	GEOTECH AUTOMATIC	100,000	PENNSTAC
20,000	MAGNEFILE B	110,000	PROGRAMMED DATA PROCESSOR
22,500	ELECOM 50	120,000	MODAC 410
24,500	MONROBOT XI	120,000	RPC 9000
29,750	BURROUGHS E 101	125,600	IBM 1401
29,750	BURROUGHS E 102	127,000	FOSDIC
29,750	BURROUGHS E 103	141,980	GENERAL MILLS AD/ECS
36,000	IBM 609	150,000	MODAC 414
40,500	PACKARD BELL 250	155,000	ELECOM 125 125FP
45,000	DISTRIBUTAPE	160,000	BURROUGHS D 204
49,500	BENDIX G 15	167,850	IBM 305 RAMAC
49,500	LPG 30	170,000	HONEYWELL 290
50,000	ALWAC II	175,000	UNIVAC STEP
50,000	HAMPSHIRE CCC 500	182,000	IBM 650 RAMAC TAPES
50,000	MAGNEFILE D	185,000	OARAC
50,000	TRICE	196,000	RCA 301
50,000 to 100,000	HAMPSHIRE TRTDS 932	200,000	BURROUGHS 204
55,000	BENDIX D 12	200,000	BURROUGHS 205
55,000	IBM 610	200,000	GENERAL ELECTRIC 225
56,300	NATIONAL 390	200,000	RASTAC
60,000	CDC 160	200,000	RASTAD
60,000	ELECOM 100	225,000	GENERAL ELECTRIC 210
64,000	IBM 1620	225,000	NUMERICORD
65,000	NATIONAL 102 D	230,000	IBM 701
70,000	NATIONAL 102 A	250,000	MANIAC I
70,000	READIX	257,000	RCA 501
75,000	IBM CPC	300,000	ILLIAC
75,000	UNIVAC 60	300,000	TELEREGISTER MAGNET INVENT CONT
76,950	ALWAC III E	300,000	UNIVAC FILE 1
80,000	AN/MJQ 1 REDSTONE	300,000	UNIVAC FILE 0
80,000	CIRCLE	320,000	BURROUGHS 220
82,500	NATIONAL 315	347,500	UNIVAC SOLID STATE 80/90
84,500	LIBRATROL 500	350,000	MANIAC II
85,000	MINIAC II	350,000	UNIVERSAL DATA TRANS
85,000	MODAC 5014	354,000	LOGISTICS
85,200	GENERAL ELECTRIC 312	358,000	IBM 702

TABLE XIV (CONTINUED)

APPROXIMATE COST OF COMPUTING SYSTEMS
(BASIC OR TYPICAL SYSTEM)

$ 366,600	NATIONAL 304
400,000	RICE UNIVERSITY
400,000	SWAC
467,000	EDVAC
478,000	BENDIX G 20
500,000	AN/TYK 6v BASICPAC
500,000	GEORGE
500,000	UDEC I II III
500,000 (Donated)	UNIVAC 1101
600,000	MERLIN
600,000	NORDEN VOTE TALLY
600,000	ORDVAC
700,000	UNIVAC III
750,000	CDC 1604
750,000	UNIVAC I
800,000	AF/CRC
813,250	IBM 7070
839,700	RCA 601
895,000	UNIVAC 1103 1103A
970,000	UNIVAC II
975,000	HONEYWELL 800
1,000,000	ITT SPES 025
1,000,000	LINCOLN CC 24
1,000,000	NATIONAL 107
1,284,350	IBM 7074
1,400,000	UNIVAC 1102
1,500,000	NAREC
1,500,000	UNIVAC 490
1,600,000	PHILCO CXPQ
1,640,000	IBM 705 I II
1,800,000 to 2,700,000	UNIVAC 1107
1,932,000	UNIVAC 1105
1,994,000 (Excluding Discount)	IBM 704
2,000,000	BRLESC
2,179,100	DATAMATIC 1000
2,200,000	IBM 7080
2,500,000	NORC
2,630,000	IBM 709
2,898,000	IBM 7090
4,500,000	BIZMAC I
6,000,000	UNIVAC LARC

TABLE XV

CHRONOLOGICAL ORDER OF INITIAL DATE OF OPERATION OF COMPUTING SYSTEMS

INITIAL DATE OF OPERATION	SYSTEM
May 1950	SEAC
1950	WHIRLWIND II
Mar 1951	SWAC
Mar 1951	UNIVAC I
1951	EDVAC
Mar 1952	MANIAC I
Mar 1952	ORDVAC
Sep 1952	ILLIAC
1952	ELECOM 100
Mar 1953	LOGISTICS
Apr 1953	OARAC
May 1953	IBM 701
Aug 1953	MAGNEFILE D
Aug 1953	UNIVAC 1103 1103 A
Dec 1953	UDEC I II III
1953	IBM 604
1953	NATIONAL 102 A
Feb 1954	MAGNEFILE B
Mar 1954	JOHNNIAC
Apr 1954	DYSEAC
Jun 1954	ALWAC II
Jun 1954	CIRCLE
Jul 1954	MODAC 5014
Sep 1954	MODAC 404
1954	BENDIX D 12
1954	BURROUGHS 204
1954	BURROUGHS 205
1954	IBM 650 RAMAC TAPES
1954	LGP 30
1954	WISC
Feb 1955	IBM 702
Feb 1955	MONROBOT III
Feb 1955	NORC
Mar 1955	MINIAC II
Mar 1955	MONROBOT V
Aug 1955	UNIVAC 1101
Nov 1955	BIZMAC I
1955	ALWAC III E
1955	BURROUGHS E 101
1955	IBM 705 I II
1955	MODAC 410
1955	PENNSTAC
1955	UNIVAC 60
1955	UNIVAC 120
1955	UNIVAC 1102
Feb 1956	READIX
Apr 1956	AF/CRC
Apr 1956	IBM 704
Oct 1956	MODAC 414
1956	BENDIX G 15
1956	BIZMAC II
1956	ELECOM 50
1956	ELECOM 120
1956	ELECOM 125 125FP
1956	IBM 608
1956	LEPRECHAUN
1956	MONROBOT MU
1956	NAREC
1956	PHILCO 1000
1956	RECOMP I CP 266
1956	TELEREGISTER MAGNET INVENT CONT
Sep 1957	GEORGE
Sep 1957	UNIVAC FILE 0
Nov 1957	AN/FSQ 7 AN/FSQ 8 (SAGE)
1957	IBM 709
1957	LINCOLN TX 0
1957	MANIAC II
1957	PHILCO 2000
May 1958	UNIVAC II
Sep 1958	AN/MJQ 1 REDSTONE
1958	IBM 610
1958	LINCOLN TX 2
1958	WRU SEARCHING SELECTOR
Jan 1959	RCA 501
Feb 1959	BURROUGHS 220
Feb 1959	UNIVAC 1105
Jul 1959	GE 100 ERMA
Sep 1959	FOSDIC
Nov 1959	NATIONAL 304
1959	AN/TYK 6v BASICPAC
1959	GENERAL ELECTRIC 210
1959	LIBRASCOPE AIR TRAFFIC
1959	LIBRASCOPE ASN 24
1959	RASTAD

TABLE XV (CONTINUED)

CHRONOLOGICAL ORDER OF INITIAL DATE OF OPERATION OF COMPUTING SYSTEMS

INITIAL DATE OF OPERATION	SYSTEM
1959	RPC 9000
1959	RW 300
1959	TRICE
1959	UNIVAC SOLID STATE 80/90
Jan 1960	CDC 1604
Jan 1960	HUGHES BM GUIDANCE
Jan 1960	UNIVERSAL DATA TRANS
Apr 1960	SYLVANIA UDOFTT
Apr 1960	UNIVAC LARC
Aug 1960	BENDIX CUBIC TRACKER
Oct 1960	BURROUGHS D 209
1960	AMOS IV
1960	AN/USQ 20
1960	CUBIC AIR TRAFFIC
1960	CUBIC TRACKER
1960	DIANA
1960	FADAC
1960	GENERAL ELECTRIC 225
1960	GENERAL MILLS APSAC
1960	GENERAL MILLS AD/ECS
1960	GENERAL ELECTRIC 312
1960	HAMPSHIRE TRTDS 932
1960	HRB SINGER
1960	HONEYWELL 800
1960	HUGHES DIGITAIR
1960	INTELEX AIRLINE RESERVATION
1960	IBM 1401
1960	IBM 1410
1960	7070
1960	IBM 7080
1960	IBM 7090
1960	IBM STRETCH
1960	LEEDS NORTHROP 3000
1960	LIBRASCOPE MK 130
1960	LIBRASCOPE 407
1960	LIBRATROL 1000
1960	LITTON DATA ASSESSOR
1960	MANIAC III
1960	MERLIN
1960	MOBIDIC A
1960	MOBIDIC B
1960	MOBIDIC C D & 7A
1960	NATIONAL 315
1960	NATIONAL 390
1960	NORDEN VOTE TALLY
1960	ORACLE
1960	PACKARD BELL 250
1960	PERK I II
1960	PHILCO 3000
1960	PROGRAMMED DATA PROCESSOR
1960	RCA 200
1960	RCA 300
1960	RPC 4000
1960	RASTAC
1960	RW 400
1960	REPAC
1960	SCRIBE
1960	SPEC
1960	STORED PROGRAM DDA
1960	SYLVANIA S 9400
1960	TARGET INTERCEPT
1960	UNIVAC III
1960	UNIVAC STEP
1960	WESTINGHOUSE AIRBORNE
Apr 1961	BRLESC
Jul 1961	RCA 601
Nov 1961	UNIVAC 490
1961	AN/TYK 7v INFORMER
1961	IBM 7074
1961	ITT BANK IN PROC
1961	ITT SPES 025
1961	OKLAHOMA UNIV
1961	RCA 110
1961	RICE UNIVERSITY
1962	UNIVAC 1107

CHAPTER IV

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Bell, Wm. D. "A Management Guide to Electronic Computers", McGraw-Hill, 1957.

2. Berkeley, E. C. "Computers: Their Operation & Applications", Reinhold, 1956.

3. Berkeley, E. C. "Giant Brains", John Wiley, 1949.

4. Caldwell, Samuel H. "Switching Circuits & Logical Design", John Wiley, 1958.

5. Canning, Richard G. "Installing Electronic Data Processing Systems", John Wiley, 1957.

6. Canning, Richard G. "Electronic Data Processing for Business & Industry", John Wiley, 1956.

7. Casey, R. S. and Perry, J. W. "Punched Cards", Reinhold, Copyright 1951, Second printing 1952.

8. Chapin, Ned "An Introduction to Automatic Computers", Van Nostrand, 1957.

9. Charnes, A., Cooper, W. W., Henderson, A., et. al. "Introduction to Linear Programming", Wiley, 1953.

10. Culbertson, James T. "Mathematics & Logic for Digital Computers", Van Nostrand, Copyright 1958.

11. Doss, Milburn P. "Information Processing Equipment", Reinhold, 1955.

12. Dwyer, P. A. "Linear Computations", Wiley, 1951.

13. Eckert, W. J. and Jones, R. "Faster, Faster", McGraw-Hill, 1955.

14. Gottlieb, C. C. and Hume, J. N. P. "High-Speed Data Processing", McGraw-Hill, 1958.

15. Grabbe, E. M., Ramo, S. and Wooldridge, D. E., (Editors) "Handbook of Automation, Computation and Control", Vol I: Control Fundamentals; Vol II: Computers & Data Processing; Vol III: Systems & Components, Wiley, 1959.

16. Gregory, R. H. and Van Horn, R. L. "Automatic Data Processing Systems", Wadsworth Pub. Co., 1960.

17. Harvard University, Staff of Computation Lab. "Synthesis of Electronic Computing & Control Circuits", Harvard University Press, 1951.

18. Harvard University, Staff of Computation Lab. "Description of a Magnetic Drum Calculator", Harvard University Press, 1952.

19. Householder, Alston S. "Principles of Numerical Analysis", McGraw-Hill, 1953.

20. Keister, Wm., Ritchie, A. E., Washburn, S. H., et. al. "Design of Switching Circuits", Van Nostrand.

21. Korn, G. A. and T. M. "Electronic Analog Computers", McGraw-Hill, 1956.

22. Kozmetsky, G. and Kircher, P. "Electronic Computers & Management Control", McGraw-Hill, 1956.

23. Lewis, I. A. D. and Wells, F. H. "Millimicrosecond Pulse Techniques", Pergamon, 1955.

24. McCracken, D. D. "Digital Computer Programming", Wiley, 1957.

25. Millman, Jacob & Taub, H. "Pulse & Digital Circuits", McGraw-Hill, 1956.

26. Montgomerie, G. A. "Digital Calculating Machines & Their Application to Scientific & Engineering Work", Van Nostrand, 1957.

27. Murphy, John S. "Basics of Digital Computers", John F. Rider, Copyright 1958.

28. Ore, Oystein "Number Theory & Its History", McGraw-Hill, 1948.

29. Phister, M., Jr. "Logical Design of Digital Computers", Wiley, 1958.

30. Pressman, Abraham I. "Design of Transistorized Circuits for Digital Computers", John F. Rider, 1959.

31. Richards, R. K. "Arithmetic Operations in Digital Computers", Van Nostrand, 1955.

32. Richards, R. K. "Digital Computer Components & Circuits", Van Nostrand, 1957.

33. Scott, N. R. "Analog & Digital Computer Technology", McGraw-Hill, 1960.

34. Smith, Charles V. L. "Electronic Digital Computers", McGraw-Hill, Copyright 1959.

35. Soroka, W. W. "Analog Methods in Computation & Simulation", McGraw-Hill, 1954.

36. Stewart, W. Earl "Magnetic Recording Techniques", McGraw-Hill, Copyright 1958.

37. Stibitz, Geo. R. and Larrivee, Jules A. "Mathematics & Computers", McGraw-Hill, 1957.

38. Svoboda, Antonin "Computing Mechanisms & Linkages", McGraw-Hill, 1948.

39. Tompkins, C. B., Wakelin, J. H. and Stifler, W. W., Engineering Res. Associates "High Speed Computing Devices", McGraw-Hill, 1950.

40. Wass, C. A. A. "Introduction to Electronic Analogue Computers", Pergamon, 1955.

41. Wilkes, Maurice V. "Automatic Digital Computers", Wiley, 1956.

42. Weik, Martin H. "A Survey of Domestic Electronic Digital Computing Systems", Ballistic Research Laboratories Report No. 971, Reprinted by United States Department of Commerce Office of Technical Services, PB111996.

43. Weik, Martin H. A Second Survey of Domestic Electronic Digital Computing Systems", Ballistic Research Laboratories Report No. 1010, Reprinted by United States Department of Commerce Office of Technical Services, 111996 R.

44. Automatic Data Processing Systems: Department of the Army Regulations and Pamphlets

Acquisition and use for business type operations: policies, procedures, etc.	AR 1-250
Catalog of commercially available	DA Pam 1-250-4
Conducting studies	DA Pam 1-250-1
Industrial, scientific, and office types, Logistics responsibilities	AR 701-7440
Introduction	DA Pam 1-250-3
Program planning guide	DA Pam 1-250-2

CHAPTER V

GLOSSARY OF COMPUTER ENGINEERING AND PROGRAMMING TERMINOLOGY

(REVISED)

AC

a suffix meaning "automatic computer" as in ORDVAC, EDVAC, ENIAC, etc.

ACCESS, RANDOM

access to storage under conditions in which the next position from which information is to be obtained is in no way dependent on the previous one.

ACCESS TIME

(1) the time interval between the instant at which information is: (a) called for from storage and the instant at which delivery is completed, i.e., the read time; or (b) ready for storage and the instant at which storage is completed, i.e., the write time. (2) the latency plus the word-time.

ACCUMULATOR

the "zero-access" register (and associated equipment) in the arithmetic unit in which are formed sums and other arithmetical and logical results; a unit in a digital computer where numbers are totaled, i.e., accumulated. Often the accumulator stores one operand and upon receipt of any second operand, it forms and stores the sum of the first and second operands.

ACCURACY

freedom from error. Accuracy contrasts with precision; e.g., a four-place table, correctly computed, is accurate; a six-place table containing an error is more precise, but not accurate.

ADDER

a device capable of forming the sum of two or more quantities.

ADDRESS

a label such as an integer or other set of characters which identifies a register, location of device in which information is stored.

ADDRESS, ABSOLUTE

the label(s) assigned by the machine designer to a particular storage location; specific address.

ADDRESS, RELATIVE

a label used to identify a word in a routine or subroutine with respect to its position in that routine or subroutine. Relative addresses are translated into absolute addresses by the addition of some specific "reference" address, usually that at which the first word of the routine is stored, e.g. if a relative address instruction specifies an address n and the address of the first word of the routine is k, then the absolute address is n + k.

ADDRESS, SYMBOLIC

a label chosen to identify a particular word, function or other information in a routine, independent of the location of the information within the routine; floating address.

ALLOCATE

to assign storage locations to the main routines and subroutines, thereby fixing the absolute values of any symbolic addresses. In some cases allocation may require segmentation.

AMPLIFIER, BUFFER

an amplifier used to isolate the output of any device, e.g. oscillator, from the effects produced by changes in voltage or loading in subsequent circuits.

AMPLIFIER, TORQUE

a device which produces an output turning moment in proportion to the input moment, wherein the output moment and associated power is supplied by the device, and the device requires an input moment and power smaller than the output moment and power.

ANALOG

the representation of numerical quantities by means of physical variables, e.g. translation, rotation, voltage, resistance; contrasted with "digital".

ANALYZER, DIFFERENTIAL

an analog computer designed and used primarily for solving many types of differential equations.

AND-OPERATOR

a logical operator which has the property such that if P and Q are two statements, then the statement "P and Q" is true or false precisely according to the following table of possible combinations:

P		Q		P and Q	
false	0	false	0	false	0
false	0	true	1	false	0
true	1	false	0	false	0
true	1	true	1	true	1

The "and" operator is often represented by a centered dot (·), or by no sign, as in P · Q or PQ; the term conjunction is applied to this operator.

AND-GATE

a signal circuit with two or more input wires which has the property that the output wire gives a signal if and only if all input wires receive coincident signals.

AQUADAG

a graphite coating on the inside of certain cathode ray tubes for collecting secondary electrons emitted by the screen.

ARITHMETIC UNIT

that portion of the "hardware" of an automatic computer in which arithmetic and logical operations are performed.

ASSEMBLE

to integrate subroutines (supplied, selected, generated) into the main routine, by adapting, or specializing to the task at hand by means of preset parameters, by adapting, or changing relative and symbolic addresses to absolute form, or incorporating, or placing in storage.

ATTENUATE

to obtain a fractional part or reduce in amplitude an action or signal. Measurement may be made as percentage, per unit, or in decibels, which is 10 times $\log_{10}$ of power ratio; contrasted with amplify.

AUTOMATION

the entire field of investigation, design, development, application and methods of rendering or making processes or machines self-acting or self-moving; rendering automatic; theory, art of technique of making a device, machine, process or procedure more fully automatic; the implementation of a self-acting or self-moving, hence, automatic process or machine.

AVAILABLE-TIME, MACHINE

time during which a computer has the power turned on, is not under maintenance, and is known or believed to be operating correctly.

AZIMUTH

the angular measurement in an horizontal plane and in a clockwise direction from a specific reference direction, usually a form of North, i.e., true azimuth is measured from true north, magnetic azimuth from magnetic north, grid-azimuth from grid north or thrust or base line.

BAND

a group of recording tracks on a magnetic drum.

BASE

a number base; a quantity used implicitly to define some system of representing numbers by positional notation; radix.

BEAM, HOLDING

a diffused beam of electrons used for regenerating the charges stored on the screen of a cathode ray storage tube.

BIAS

the average D.C. voltage maintained between the cathode and control grid of a vacuum tube; a fixed reference located with respect to a neutral or zero reference.

BINARY

a characteristic or property involving a selection, choice or condition in which there are but two possible alternatives.

BINARY, NUMBER

a single digit or group of characters or symbols representing the total, aggregate or amount of units utilizing the base two; usually using only the digits "0" and "1" to express quantity.

BIQUINARY

a form of notation utilizing a mixed base; see Notation, Biquinary.

BIT

a contraction of binary digit; see Digit, Binary.

BLOCK

a group of words considered or transported as a unit; an item; a message; in flow charts, an assembly of boxes, each box representing a logical unit of programming, usually requiring transfer to and from the high speed storage; in circuitry, a group of electrical circuits performing a specific function, as in a "block" diagram, in which a unit, e.g., an oscillator, is represented as a geometric figure (symbol).

BLOCK, INPUT

a section of internal storage of a computer reserved for the receiving and processing of input information; input buffer.

BOOTSTRAP

the special coded instructions at the beginning of an input tape, together with one or two instructions inserted by switches or buttons into the computer; in circuitry, a positive feedback or regenerative circuit

BORROW

a negative form of carry; see Carry; normally arising in direct subtraction by raising a lower order (less significant digit) and compensating by lowering a higher order digit e.g. when subtracting 67 from 92, a tens digit is "borrowed" from the 9, thus the 7 of 67 is subtracted from 12, yielding 5 as the units digit of the difference and then 6 is subtracted from 8 (or 9-1) yielding 2 as the tens digit. Thus, 25 is the difference.

BRANCH

a conditional jump; a point of decision in a program where a new routine or sub-routine is entered upon.

BREAKPOINT

a point in a routine at which the computer may, under the control of a manually-set switch, be stopped for a visual check of progress.

BUFFER

an isolating circuit used to avoid any reaction of a driven circuit upon the corresponding driving circuit, e.g. a circuit having an output and a multiplicity of inputs so designed that the output is energized whenever one or more inputs are energized. Thus, a buffer performs the circuit function or isolation which is equivalent to the logical "OR".

BUS

a path over which information is transferred; a trunk; an electrical conductor, channel or line; a heavy wire or heavy lead upon which many connections are made.

CABLE

an electrical conductor designed to provide common electric potential between two or more points.

CABLE, COAXIAL

a transmission line consisting of two conductors concentric with and insulated from each other.

CALL-NUMBER

a set of characters identifying a subroutine and containing information concerning parameters to be inserted in the subroutine, information to be used in generating the subroutine, or information related to the operands; a call-word when exactly one word is filled.

CAPACITANCE

the property of two or more bodies which enables them to store electrical energy in an electrostatic field between the bodies; a measure of the ability to store electric charge.

CAPACITY

the upper and lower limits of the numbers which may be processed in a computer register, e.g., in the accumulator, e.g. the capacity of a computer may be ten decimal digits or the capacity of a computer may be +.00000 00001 to +.99999 99999. Quantities which exceed the capacity usually interrupt the operation of the computer in some fashion; the quantity of information which may be stored in a storage unit; see Capacity,Storage.

CAPACITY, STORAGE

maximum number of words or characters which a device is capable of storing; a measure of the ability of a device to store information for future reference.

CARD

heavy, stiff paper of uniform size and shape, adapted for being punched in an intelligible array of holes. The punched holes are sensed electrically by wire brushes, mechanically by metal feelers, or photoelectrically. One standard card, is 7 3/8 inches long by 3 and 1/4 inches wide and contains 80 columns in each of which any one or more of 12 positions may be punched.

CARRIAGE, AUTOMATIC

a typewriting paper guiding or holding device which is automatically controlled by information and program so as to feed forms or continuous paper to a set of impression keys and to provide the necessary space, skip, eject, tabulate, or performing operations.

CARRIER WAVE

the basic frequency or pulse repetition rate of a signal, bearing no intrinsic intelligence until it is modulated by another signal which does bear intelligence. A carrier may be amplitude, phase, or frequency modulated. For example, in a typical mercury delay line memory of a digital computer, the 8 megacycle/second sound wave carrier is amplitude (pulse) modulated by a 1 megacycle/second pulse code signal, the presence or absence of a pulse determining whether or not a one or a zero is present in the binary number being represented.

CARRY

(1) A signal, or expression, produced as a result of an arithmetic operation on one digit place of two or more numbers expressed in Positional Notation and transferred to the next higher place for processing there; (2) Usually a signal or expression as defined in (1) above which arises in adding, when the sum of two digits in the same digit place equals or exceeds the Base of the number system in use. If a carry into a digit place will result in a carry out of of the same digit place, and if the normal adding circuit is bypassed when generating this new carry, it is called a High-Speed Carry, or Standing-on-Nines Carry. If the normal adding circuit is used in such a case, the carry is called a Cascaded Carry. If a carry resulting from the addition of carries is not allowed to propagate (e.g., when forming the partial product in one step of a multiplication process), the process is called a Partial Carry. If it is allowed to propagate, the process is called a Complete Carry. If a carry generated in the most significant digit place is sent directly to the least significant place (e.g., when adding two negative numbers using nine complements) that carry is called an End-Around Carry. (3) In direct subtraction, a signal or expression as defined in (1) above which arises when the difference between the digits is less than zero. Such a carry is frequently called a Borrow. (4) The action of forwarding a carry. (5) The command directing a carry to be forwarded.

CARRY, COMPLETE

see Carry

CARRY, CASCADED

see Carry

CARRY, HIGH-SPEED

see Carry

CARRY, PARTIAL

see Carry

CARRY, STANDING-ON-NINES

see Carry

CATHODE-FOLLOWER

a vacuum-tube circuit in which the input signal is applied to the control grid and the output is taken from the cathode, possessing high input impedance and low output impedance characteristics.

CELL

storage for one unit of information, usually one character or one word; a location specified by whole or part of the address and possessed of the faculty of store; specific terms such as column, field, location and block, are preferable when appropriate.

CELL, BINARY

an element that can have one or the other of two stable states or conditions and thus can store a single bit of information.

CHANNEL

a path along which information, particularly a series of digits or characters, may flow. In storage which is serial by character and parallel by bit (e.g., a magnetic tape or drum in some coded-decimal computers), a channel comprises several parallel tracks. In a circulating storage a channel is one recirculating path containing a fixed number of words stored serially by word.

CHARACTER

one of a set of elementary symbols such as those corresponding to the keys on a typewriter. The symbols usually includes the decimal digits 0 through 9, the letters A through Z, punctuation marks, operation symbols, and any other single symbols which a computer may read, store, or write; a pulse code representation of such a symbol.

CHECK

a means of verification of information or operation during or after an operation.

CHECK, BUILT-IN AUTOMATIC

any provision constructed in "hardware" for verifying the accuracy of information transmitted, manipulated, or stored by any unit or device in a computer. Extent of automatic checking is the relative proportion of machine "hardware" devoted to checking.

CHECK, CODE

to check a particular coded problem for errors; to de-bug a code.

CHECK-DUPLICATION

a check which requires that the results of two independent performances (either concurrently on duplicate equipment or at a later time on the same equipment) of the same operation be identical.

CHECK-FORBIDDEN-COMBINATION

a Check (usually an Automatic Check) which tests for the occurrence of a nonpermissible code expression. A self-checking code (or error-detecting code) uses code expressions such that one (or more) error(s) in a code expression produces a forbidden combination. A parity check makes use of a self-checking code employing binary digits in which the total number of 1's (or 0's) in each permissible code expression is always even or always odd. A check may be made for either even parity or odd parity. A redundancy check employs a self-checking code which makes use of redundant digits called check digits. Some of the various names that have been applied to this type of check are forbidden pulse combination, unused order (instruction) unallowable digits, improper operation code, improper command, false code, forbidden digit, non-existent code, and unused code.

CHECK, MATHEMATICAL or ARITHMETICAL

a check making use of mathematical identities or other properties, frequently with some degree of discrepancy being acceptable; e.g., checking multiplication by verifying that $A \cdot B = B \cdot A$, checking a tabulated function by differencing, etc.

CHECK, MODULO N

a form of check digits, such that the number of ones in each number A operated upon is compared with a check number B, carried along with A and equal to the remainder of A when divided by N, e.g., in a "modulo 4 check", the check number will be 0, 1, 2, or 3 and the remainder of A when divided by 4 must equal the reported check number B, or else an error or malfunction has occurred; a method of verification by congruences, e.g. casting out nines.

CHECK, ODD-EVEN

a check system in which a one or zero is carried along in a word depending on whether the total number of ones (or zeros) in a word is odd or even.

CHECK, PARITY

a summation check in which the binary digits, in a character or word, are added (modulo 2) and the sum checked against a single, previously computed parity digit; i.e., a check which tests whether the number of ones is odd or even.

CHECK, PROGRAMMED

a system of determining the correct program and machine functioning either by running a sample problem with similar programming and known answer, including mathematical or logical checks such as comparing A times B with B times A and usually where reliance is placed on a high probability of correctness rather than built-in error-detection circuits; a check system built into the actual program being run and utilized for checking during the actual running of the problem.

CHECK, REDUNDANT

a check which uses extra digits, short of complete duplication, to help detect malfunctions and mistakes.

CHECK, SUMMATION

a check in which groups of digits are summed, usually without regard for overflow, and that sum checked against a previously computed sum to verify accuracy.

CHECK, TRANSFER

verification of transmitted information by temporary storing, re-transmitting and comparing.

CHECK, TWIN

a continuous duplication check achieved by duplication of hardware and automatic comparison

CHECKING, MARGINAL

a system or method of determining computer circuit weaknesses and incipient malfunctions by varying the power applied to various circuits, usually by a lowering of the D.C. supply or filament voltages.

CLAMPING-CIRCUIT

a circuit which maintains either amplitude extreme of a waveform at a given voltage level, or potential.

CLEAR

to replace all information in a storage device by ones or zeros as expressed in the number system employed.

CLOCK, MASTER

the source of standard signals required for sequencing computer operation, usually consisting of a timing pulse generator, a cycling unit and sets of special pulses that occur at given intervals of time. Usually in synchronous machines the basic frequency utilized is the clocking pulse.

CLOSED-SHOP

this is intended to mean that mode of computing machine support wherein the applied programs and utility routines are written by members of a specific specialized group whose primary professional concern is the use of computers.

CODE

a system of symbols or their use in representing rules for handling the flow or processing of information; to actually prepare problems for solution on a specific computer.

CODE, COMPUTER

the code representing the operations built into the hardware of the computer; reperatoire of instructions.

CODE, EXCESS-THREE

a coded decimal notation for decimal digits which represents each decimal digit as the corresponding binary number plus three, e.g. the decimal digits 0, 1, 7, 9 are represented as 0011, 0100, 1010, 1100, respectively. In this notation, the nines complement of the decimal digit is equal to the ones complement of the corresponding four binary digits.

CODE, INSTRUCTION

an artificial language for describing or expressing the instructions which can be carried out by a digital computer. In automatically sequenced computers, the instruction code is used when describing or expressing sequences of instructions, and each instruction word usually contains a part specifying the operation to be performed and one or more addresses which identify a particular location in storage. Sometimes an address part of an instruction is not intended to specify a location in storage but is used for some other purpose. If more than one address is used, the code is called a multiple-address code.

CODE, INTERPRETER

a code which is acceptable to an interpretive routine.

CODE, MULTIPLE-ADDRESS

an instruction or code in which more than one address or storage location is utilized. In a typical instruction of a Four-Address Code the addresses specify the location of two operands, the destination of the result, and the location of the next instruction in the sequence. In a typical Three-Address Code, the fourth address specifying the location of the next instruction is dispensed with, the instructions are taken from storage in a preassigned order. In a typical Two-Address Code, the addresses may specify the locations of the operands. The results may be placed at one of the addresses or the destination of the results may be specified by another instruction.

CODE, OPERATIONAL

that part of an instruction which designates the operation to be performed.

CODING

the list, in computer code or in pseudo-code, of the successive computer operations required to solve a given problem; repertoire of instructions.

CODING, ABSOLUTE, RELATIVE or SYMBOLIC

coding in which one uses absolute, relative, or symbolic addresses, respectively, i.e., coding in which all addresses refer to an arbitrarily selected position, or in which all addresses are represented symbolically.

CODING, ALPHABETIC

a system of abbreviation used in preparing information for input into a computer such that information is reported in the form of letters, e.g., New York as NY, carriage return as CN, etc.

CODING, AUTOMATIC

any technique in which a computer is used to help bridge the gap between some "easiest" form, intellectually and manually, of describing the steps to be followed in solving a given problem and some "most efficient" final coding of the same problem for a given computer; two basic forms are Routine, Compilation and Routine, Interpretation.

CODING, NUMERIC

a system of abbreviation used in the preparation of information for machine acceptance by reducing all information to numerical quantities; in contrast to alphabetic coding.

COLLATE

to combine two or more similarly ordered sets of items to produce another ordered set composed of information from the original sets. Both the number of items and the size of the individual items in the resulting set may differ from those of either of the original sets and of their sums, sequence 23, 24, 48 may be collated into 12, 23, 24, 29, 42, 48; to combine two or more sequences of items according to a prescribed rule such that all items appear in the final sequence.

COLLATOR

a machine which has two card feeds, four card pockets and three stations at which a card may be compared or sequenced with regard to other cards so as to select a pocket in which it is to be placed, e.g., the machine is suitable for matching detail cards with master cards, merging cards in proper sequence, etc.

COLUMN

one of the character or digit positions in a positional notation representation of a unit of information, columns are usually numbered from right to left column, zero being the right-most column if there is no point, or the column immediately to the left of the point if there is one; a position or place in a number in which the position designates the power of the base and the digit is the coefficient e.g., in 3876, the 8 is the coefficient of 10^2; the position of the 8 designating the 2.

COMMAND

a pulse, signal, or set of signals initiating one step in the performance of a computer operation; that portion of the instruction word which specifies the operation to be performed; See instruction and order.

COMPARATOR

a device for comparing two different transcriptions of the same information to verify the accuracy of transcription, storage, arithmetic operation or other process, in which a signal is given dependent upon the relative state of two items, i.e. larger, smaller, equal, difference, etc.

COMPARE

to examine the representation of a quantity for the purpose of discovering its relationship to zero, or of two quantities usually for the purpose of discovering identity or relative magnitude.

COMPARISON

determining the identity, relative magnitude and relative sign of two quantities usually in order to initiate an action.

COMPARISON, LOGICAL

the operation concerned with the determination of similarity or dissimilarity of two items, e.g. if A and B are alike, the result shall be"1" or yes, if A and B are not alike or equal, the result shall be "0" or no, signifying "not alike".

COMPILER

a program making routine, which produces a specific program for a particular problem by determining the intended meaning of an element of informatinn expressed in pseudo-code, selecting or generating the required subroutine, transforming the subroutine into specific coding for the specific problem, assigning specific storage registers, etc. and entering it as an element of the problem program, maintaining a record of the subroutines used and their position in the problem program and continuing to the next element of information in pseudo-code.

COMPLEMENT

a quantity which is derived from a given quantity, expressed to the base n, by one of the following rules and which is frequently used to represent the negative of the given quantity. (a) Complement on n; subtract each digit of the given quantity from n-1, add unity to the least significant digit, and perform all resultant carrys. For example, the twos complement of binary 11010 is 00110; the tens complement of decimal 456 is 544. (b) Complement on n-1: subtract each digit of the given quantity from n-1. For example, the ones complement of binary 11010 is 00101; the nines complement of decimal 456 is 543.

COMPUTER

any device capable of accepting information, applying prescribed processes to the information, and supplying the results of these processes; sometimes, more specifically, a device for performing sequences of arithmetic and logical operations; sometimes, still more specifically, a stored-program digital computer capable of performing sequences of internally-stored instructions, as opposed to calculators on which the sequence is impressed manually (desk calculator) or from tape or cards (card programmed calculator).

COMPUTER, ANALOG

a calculating machine which solves problems by translating physical conditions like flow, temperature or pressure into electrical quantities and using electrical equivalent circuits for the physical phenomenon.

COMPUTER, ASYNCHRONOUS

a calculating device in which an operation is initiated by a signal generated upon completion of a previous operation; contrasted with Synchronous Computer.

COMPUTER, AUTOMATIC

a calculating device which handles long sequences of operations without human intervention.

COMPUTER, DIGITAL

a calculating device utilizing numbers to express all the variables and quantities of a problem. The numbers are usually expressed as a space-time distribution of punched holes, electrical pulses, sonic pulses, etc.

COMPUTER, SYNCHRONOUS

a calculating device in which the performance of all operations is controlled with periodic signals from a master clock.

CONJUNCTION

in logical design, normally an "And" function; see And-Operator.

CONTENTS

the information stored in any storage medium. Quite prevalently, the symbol ( ) is used to indicate "the contents of"; e,g., (m) indicates the contents of the storage location whose address is m; (A) indicates the contents of register A; (T_2) may indicate the contents of the tape on input-output unit two.

CONTROL

(1) Usually, those parts of a digital computer which effect the carrying out of instructions in proper sequence, the interpretation of each instruction, and the application of the proper signals to the arithmetic unit and other parts in accordance with this interpretation. (2) Frequently, one or more of the components in any mechanism responsible for interpreting and carrying out manually-initiated directions. Sometimes called manual control. (3) In some applications of mathematics, a mathematical check.

CONTROL, CASCADE

an automatic control system in which various control units are linked in sequence, each control unit regulating the operation of the next control unit in line.

CONTROL-SEQUENCE

the normal order of selection of instructions for execution. In some computers, one of the addresses in each instruction specifies the control sequence. In most other computers the sequence is consecutive except where a Jump occurs.

CONTROL, SEQUENTIAL

a manner of operation of a computer such that instructions are fed to or stored in the computer in a given order during the solution of a problem and the computer executes these instructions in a given order.

CONTROL-UNIT

that portion of the hardware of an automatic digital computer which directs the sequence of operations, interprets the coded instructions, and initiates the proper commands to the computer circuits to execute the instructions.

CONVERT

to change numerical information from one number base to another (e.g., decimal to binary) and/or from some form of fixed point to some form of floating-point representation, or vice versa; occasionally to transfer information from one recorded medium to another.

CONVERTER

a unit which changes the language of information from one form to another so as to make it available or acceptable to another machine, e.g., a unit which takes information punched on cards to information recorded on magnetic tape, possibly including editing facilities.

COPY

to reproduce information in a new location, replacing whatever was previously stored there, and usually leaving the information unchanged at the original location.

CORE, MAGNETIC

a magnetic material capable of assuming and remaining at one of two or more conditions of magnetization, thus capable of providing storage, gating or switching functions, usually of toroidal shape and pulsed or polarized by electric currents carried on wire adjacent the material.

COUNTER

a device, register, or storage location for storing numbers or integers, permitting these integers to be increased or decreased by unity or by an arbitrary number or integer, and capable of being reset to zero or to an arbitrary number.

COUNTER, CONTROL

a device which records the storage location of the instruction word, which is to be operated upon following the instruction word in current use. The control counter may select storage locations in sequence, thus obtaining the next instruction word from the subsequent storage location, unless a transfer or special instruction is encountered.

COUNTER, RING

a loop of interconnected bistable elements such that one and only one is in a specified state at any given time and such that, as input signals are counted, the position of the element in the specified state "moves" in an ordered sequence around the loop.

COUPLING

the means by which energy is transferred from one circuit to another; the common impedance necessary for coupling.

COUPLING, CAPACITIVE

a method of transferring energy from one circuit to another by means of a capacitor that is common to both circuits.

COUPLING, DIRECT

a method of transferring energy from one circuit to another by means of resistors common to both circuits.

CRT

cathode ray tube; a device yielding a visual plot of the variation of several parameters by means of a proportionally deflected beam of electrons.

CYBERNETICS

the comparative study of the control and intra-communication of information handling machines and nervous systems of animals and man in order to understand and improve communication.

CYCLE

a set of operations repeated as a unit; a non-arithmetic shift in which the digits dropped off at one end of a word are returned at the other end in circular fashion; cycle right and cycle left. To repeat a set of operations a prescribed number of times including, when required, supplying necessary address changes by arithmetic processes or by means of a hardware device such as a B-box or cycle-counter.

CYCLE COUNT

to increase or decrease the cycle index by unity or by an arbitrary integer or number.

CYCLE-CRITERION

the total number of times the cycle is to be repeated; the register which stores that number.

CYCLE-INDEX

the number of times a cycle has been executed; or the difference, or the negative of the difference, between that number and the number of repetitions desired.

CYCLE, MAJOR

the maximum access time of a recirculating serial storage element; the time for one rotation, e.g., of a magnetic drum or of pulses in an acoustic delay line; a whole number of minor cycles.

CYCLE, MEMORY

a repeated, periodic sequence of events occurring when information is transferred to or from the storage device of a computer. Storing, sensing, and regeneration form parts of the storage sequence. Usually a "timing chart", showing pulse times on all leads to a storage cell describe such a cycle.

CYCLE, MINOR

the word time of a serial computer, including the spacing between words.

CYCLE, RESET

to return a cycle index to its initial value.

DAMPING

a characteristic built into electrical circuits and mechanical systems to prevent rapid or excessive corrections which may lead to instability or oscillatory conditions, e.g., connecting a resistor on the terminals of a pulse transformer to remove natural oscillations; placing a moving element in oil or sluggish grease to prevent overshoot.

DATA-REDUCTION

the art or process of transforming masses of raw test or experimentally obtained data, usually gathered by instrumentation, into useful, ordered, or simplified intelligence.

DATA-REDUCTION, ON-LINE

the processing of information as rapidly as the information is received by the computing system or as rapidly as it is generated by the source.

DEBUG

to isolate and remove all malfunctions from a computer or all mistakes from a routine.

DECADE

a group or assembly of ten units, e.g., a decade counter counts to ten in one column; a decade resistor box inserts resistance quantities in multiples of powers of 10; ten years.

DECIMAL, CODED, BINARY

decimal notation in which the individual decimal digits are represented by some binary code, e.g., in the 8-4-2-1 coded decimal notation, the number twelve is represented as 0001 0010 for 1 and 2, respectively, whereas in pure binary notation, it is represented as 1100. Other coded decimal notations are used, e.g., 5-4-2-1, excess three, 2-4-2-1, etc.

DECODE

to ascertain the intended meaning of the individual characters or groups of characters in the pseudo-coded program.

DECODER

a device capable of ascertaining the significance or meaning of a group of signals and initiating a computer event based thereon; matrix.

DECREMENT-FIELD

a portion of an instruction word set aside specifically for modifying the contents of a register or memory location specified by the tag digits of the same instruction word.

DEFLECTION-SENSITIVITY

in connection with Cathode Ray Tubes, it is the quotient of the displacement of the electron beam at the place of impact by the change in deflecting as was. It is usually expressed in millimeters per volt applied between the deflection electrodes, or in millimeters per gauss of the deflecting magnetic field.

DELAY-LINE, ELECTRIC

a transmission line of lumped or distributed capacitive and inductive elements in which the velocity of propagation of electromagnetic energy is small compared with the velocity of light. Storage may be accomplished by re-circulation of wave patterns containing information, usually in binary form.

DELAY-LINE, MAGNETIC

a magnetic medium along which the velocity of propagation of magnetic energy is small relative to the speed of light. Storage is accomplished by recirculation of wave patterns containing information, usually in binary form.

DELAY-LINE, MERCURY or QUARTZ

a sonic or acoustic delay-line in which mercury or quartz is used as the medium of sound transmission, with transducers on each end to permit conversion to and from electrical energy; See Delay-line, Sonic or Acoustic.

DELAY-LINE, SONIC or ACOUSTIC

a device capable of transmitting retarded sound pulses, transmission being accomplished by wave patterns of elastic deformation. Storage is accomplished by re-circulation of wave pattersn containing information, usually in binary form.

DENSITY, PACKING

the number of units of useful information contained within a given linear dimension, usually expressed in units per inch, e.g., the number of binary digit magnetic pulses stored on tape or drum per linear inch on a single track by a single head.

DESIGN, LOGICAL

(1) The planning of a computer or data-processing system prior to its detailed engineering design. (2) The synthesizing of a network of logical elements to perform a specified function. (3) The result of (1) and (2) above, frequently called the logic of the system, machine, or network.

DIAGRAM, BLOCK

a schematic representation of a sequence of subroutines designed to solve a problem; a coarser and less symbolic representation than a flow chart, frequently including descriptions in English words; a schematic or logical drawing showing the electrical circuit or logical arrangements within a component.

DIAGRAM, LOGICAL

in logical design a diagram representing the logical elements and their interconnections without necessarily expressing construction or engineering details.

DIFFERENTIATOR

a device whose output function is proportional to a derivative of its input function with respect to one or more variables.

DIGIT

one of the n symbols of integral value ranging from 0 to n-1 inclusive in a scale of numbering of base n, e.g., one of the ten decimal digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

DIGIT, BINARY

a whole number in the binary scale of notation; this digit may be only 0 (zero) or 1 (one). It may be equivalent to an "on" or "off" condition, a "yes" or a "no", etc.

DIGIT, DECIMAL, CODED

one of ten arbitrarily-selected patterns of ones and zeros used to represent the decimal digits.

DIGITAL

the quality of utilizing numbers in a given scale of notation to represent all the quantities that occur in a problem or a calculation.

DIGITIZE

to render an analog measurement of a physical variable into a numerical value, expressing the quantity in digital form.

DIGITS, EQUIVALENT BINARY

the number of binary digits required to express a number in another base with the same precision, e.g., approximately 3 1/3 times the number of decimal digits is required to express a decimal number in binary form. For the case of coded decimal notation, the number of binary digits required is 4 times the number of decimal digits.

DISJUNCTION

in logical design, normally an "OR" function; see OR-Operator

DOWN-TIME

the period during which a computer is malfunctioning or not operating correctly due to machine failures; contrasted with available time, idle time or standby time. Scheduled maintenance time is also considered down-time, in as much as the computer is unable to operate during this period.

DRUM, MAGNETIC

a rotating cylinder on whose magnetic-material coating information is stored in the form of magnetized dipoles, the orientation or polarity of which is used to store binary information.

DUMMY

an artificial address, instruction, or other unit of information inserted solely to fulfill prescribed conditions (such as word-length or block-length) without affecting operations.

DUMP, A. C.

the removal of all A. C. power, intentionally, accidentally or conditionally from a system or component. An A. C. dump usually results in the removal of all power.

DUMP, D. C.

the removal of all D.C. power, intentionally, accidentally, or conditionally, from a system or component.

DUMP, POWER

the removal of all power accidentally or intentionally.

ECCLES-JORDAN (TRIGGER)

a direct coupled multivibrator circuit possessing two conditions of stable equilibrium. Also known as a flip-flop circuit or "toggle".

ECHO CHECKING

a system of assuring accuracy by reflecting the transmitted information back to the transmitter and comparing the reflected information with that which was transmitted.

EDIT

to rearrange information. Editing may involve the deletion of unwanted data, the selection of pertinent data, the insertion of invariant symbols such as page numbers and typewriter characters, and the application of standard processes such as zero-suppression.

ELECTRONIC

pertaining to the application of that branch of science which deals with the motion, emission and behavior of currents of free electrons, especially in vacuum, gas or phototubes and special conductors or semi-conductors. Contrasted with electric which pertains to the flow of large currents in wires or conventional conductors.

ELEMENT, LOGICAL

in a computer or data-processing system, the smallest building blocks which can be represented by operators in an appropriate system of symbolic logic. Typical logical elements are the and-gate and the flip-flop, which can be represented as operators in a suitable symbolic logic.

ELEVATION

the angular measurement in a vertical plane from a specific reference, usually the horizontal plane.

ENCODER

a network or system in which usually one input is excited at a time and each input produces a combination of outputs. Sometimes called matrix.

ERASE

to replace all the binary digits in a storage device by binary zeros. In a binary computer, erasing is equivalent to clearing, while in a coded decimal computer where the pulse code for decimal zero may contain binary ones, clearing leaves decimal zero while erasing leaves all-zero pulse codes.

ERROR

the amount of loss of precision in a quantity; the difference between an accurate quantity and its calculated approximation; errors occur in numerical methods, e.g. an error introduced by the truncation of a power series defining a transcen dental function. This may be classified as an error introduced by the numerical method, there is no mistake involved and the computer is operating properly; mistakes occur in programming, coding, data transcription, and operating; thus, usually humans make mistakes, e.g., assigning a wrong address when coding a problem; malfunctions occur in computers and are due to physical limitations on the properties of materials. An error is sometimes considered to be the differential margin by which a controlled unit deviates from its target value.

ERROR, INHERITED

the error in the initial values; especially the error inherited from the previous steps in the step-by-step integration. This error could also be the error introduced by the inability to make exact measurements of physical quantities.

ERROR, ROUNDING

the error resulting from deleting the less significant digits of a quantity and applying some rule of correction to the part retained. A common round-off rule is to take the quantity to the nearest digit. Thus, pi, 3.14159265..., rounded to four decimals is 3.1416. Note; Alston S. Householder suggests the following terms: "initial errors","generated errors", propagated errors" and "residual errors". If x is the true value of the argument, and x^* the quantity used in computation, then assuming one wishes $f(x)$, $x-x^*$ is the initial error; $f(x) - f(x^*)$ is the propagated error. If f_a is the Taylor, or other, approximation utilized, then $f(x^*) - f_a(x^*)$ is the residual error. If f^* is the actual result then $f_a - f^*$ is the generated error, and this is what builds up as a result of rounding.

ERROR, TRUNCATION

the error resulting from the use of only a finite number of terms of an infinite series, or from the approximation of operations in the infinitesimal calculus by operations in the calculus of finite differences.

EXCHANGE

to interchange the contents of two storage devices or locations.

EXCLUSIVE-OR-OPERATOR

a logical operator which has the property that if P and Q are two statements, then the statement $P \not\equiv Q$ (i.e. $\not\equiv$ is Exclusive-Or Operator) is true or false depending whether the variables are odd or even, e. g.

P	Q	$P \not\equiv Q$	
0	1	1	(odd)
1	0	1	(odd)
1	0	1	(even)
0	0	0	(even)

Note that the Exclusive-OR is the same as the Inclusive-Or, except that the case for both inputs present yields no output. See Inclusive-OR; $P \not\equiv Q$ is True if P or Q are true, but not both. Primarily used in comparator circuits.

EXTRACT

to remove from a set of items of information all those items that meet some arbitrary criterion; to replace the contents of specific parts of a quantity (as indicated by some other quantity called an extractor) by the contents of specific parts of a third quantity, e.g., if the number 01101 is stored, the machine can remove and act upon or according to the third digit, in this case a 1.

FACTOR, SCALE

one or more coefficients used to multiply or divide quantities in a problem in order to convert them so as to have them lie in a given range of magnitude, e.g., plus one to minus one.

FEED, CARD

a mechanism which moves cards serially into a machine.

FERROELECTRIC

a phenomenon exhibited by materials within which permanent electric dipoles exist and a residual displacement in the D-E plane occurs, where $D = E + 4\pi P$, (vectorial), in which D is the electric displacement vector, E is the applied electric field strength and P is a measure of the degree of polarization. Thus, E is measurable, e.g., as potential difference per unit length force per unit charge, or lines of force per unit area. The polarization P, is measured in dipoles per unit volume or charge moved across a unit area upon application of an electric field. In ferroelectric materials there is a residual polarization, P_r.

Note the similarity for ferromagnetics: $B = H + 4\pi M$, where B is the magnetic induction, i.e. total lines of force per unit area, H is the magnetic field intensity usually produced by a distribution of electric currents and M is the magnetic polarization. It is because of the similarity of behavior, described by these two equations, that the phenomenon of ferroelectricity is described using the prefix "ferro", i.e. "pertaining to or like unto iron".

FERROMAGNETICS

in computer technology, the science that deals with the storage of information and the logical control of pulse sequences through the utilization of the magnetic polarization properties of materials to store binary information.

FIELD

a set of one or more characters (not necessarily all lying on the same word) which is treated as a whole; a set of one or more columns on a punched card consistently used to record similar information.

FIELD, CARD

a set of card columns fixed as to number and position into which the same type of information is regularly entered.

FIELD, DECREMENT

a portion of an instructor word set aside specifically for modifying the contents of a register or memory location specified by the tag digits of the same instructor word.

FILE

a sequential or organized set of items.

FIXED-POINT

a notation or system of arithmetic in which all numerical quantities are expressed by a pre-determined number of digits with the arithmetic point implicitly located at some pre-determined position; contrasted with floating-point.

FLIP-FLOP

a bi-stable device; a device capable of assuming two stable states; a bi-stable device which may assume a given stable state depending upon the pulse history of one or more input points and having one or more output points. The device is capable of storing a bit of information; a control device for opening or closing gates; a toggle. See Eccles-Jordan.

FLOATING-POINT

a notation in which a number x is represented by a pair of numbers y and z (and two integers n and m which are understood parameters, m being the number base to which y is expressed and n the base of the exponent z, in any given representation) with y and z chosen so that $x = y.n^z$ where z is an integer and where m and n are usually 2 or 10. The quantity y is called the fractional or mantissa; the integer z is called the exponent or characteristic, e.g. a decimal number 241,000,000 might be shown as 2.41, 8, since it is equal to 2.41×10^8. Here the 2.41 is assumed to be the base 10.

FLOW-CHART

a graphical representation of a sequence of operations, using symbols to represent the operations such as compute, substitute, compare, jump, copy, read, write, etc. A <u>flow chart</u> is a more detailed representation than a <u>diagram</u>.

FORCE

to intervene manually in a routine and cause the computer to execute a jump instruction.

FOUR-ADDRESS

see Code, Multiple-address.

FUNCTION-TABLE

two or more sets of information so arranged that an entry in one set selects one or more entries in the remaining sets; a dictionary; a device constructed of hardware, or a subroutine, which can either (a) decode multiple inputs into a single output or (b) encode a single input into multiple outputs; a tabulation of the values of a function for a set of values of the variable.

FUNCTOR

a logical element which performs a specific function or provides a linkage between variables. Usage not recommended.

GATE

a circuit which has the ability to produce an output which is dependent upon a specified type of or the co-incidence nature of the input, e.g. an "and" gate has an output pulse when there is time coincidence at all inputs; and "or" gate has an output when any one or any combination of input pulses occur in time coincidence; any gate may contain a number of "inhibits", in which there is no output under any condition of input if there is time coincidence of an inhibit or "except" signal.

GENERATOR

a program for a computer which generates the coding of a problem; a mechanical device which produces an electrical output.

GRID, CONTROL

the electrode of a vacuum tube other than a diode upon which a signal voltage is impressed in order to control the plate current; usually electrode number 1.

HALF-ADDER

a circuit having two output points, S and C, and two input points, A and B, such that the output is related to the input according to the following table:

INPUT		OUTPUT	
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

If A and B are arbitrary input pulses, and S and C are "sum without carry" and carry, respectively, it may be seen that two half-adders, properly connected may be used for performing binary addition.

HARDWARE

the mechanical, magnetic, electronic and electrical devices from which a computer is fabricated; the assembly of material forming a computer or component thereof.

HEAD

a device which reads, records or erases information in a storage medium, usually a small electromagnet used to read, write or erase information on a magnetic drum or tape or the set of perforating or reading fingers and block assembly for punching or reading holes in paper tape or cards.

HOLD

the function of retaining information in one storage device after transferring it to another device; in contrast to clear.

HUNTING

a continuous attempt on the part of an automatically controlled system to seek a desired equilibrium condition. The system usually contains a standard, a method of determining deviation from this standard and a method of influencing the system such that the difference between the standard and the state of the system is brought to zero. See Servomechanism.

IGNORE

an instruction requiring non-performance of what normally might be executed; not to be executed; a typewriter character indicating that no action whatsoever be taken. (In Teletype or Flexowriter code, all holes punched is an ignore).

IMPEDANCE, CHARACTERISTIC

the ratio of voltage to current at every point along a transmission line on which there are no standing waves; the square root of the product of the open and short circuit impedance of the line. When a transmission line is terminated in its characteristic impedance, energy is not reflected, but is fully absorbed in the terminating impedance.

INCLUSIVE-OR-OPERATOR

see OR-OPERATOR. P or Q is True if P or Q or both is True; when the term OR is used alone, as in OR-gate, the Inclusive-OR is usually implied; buffer.

INFORMATION

an aggregation of data.

INPUT

the information which is transferred from external storage into the internal storage; a modifier designating the device performing this function.

INSTRUCTION

a set of characters which defines an operation together with one or more addresses (or no address) and which, as a unit, causes the computer to operate accordingly on the indicated quantities. The term "instruction" is preferable to the terms "command" and "order"; command is reserved for electronic signals; order is reserved for "the order of the characters" (implying sequence) or "the order of the interpolation", or "the order of the differential equation".

INSTRUCTION, BREAKPOINT

an instruction which, if some specified switch is set, will cause the computer to stop.

INSTRUCTION, BREAKPOINT, CONDITIONAL

a conditional jump instruction which, if some specified switch is set or situation exists, will cause the computer to stop, after which either the routine may be continued as coded or a jump may be forced.

INSTRUCTION, MULTIPLE-ADDRESS

see code, Multiple-address.

INSTRUCTION, ONE-ADDRESS

an instruction consisting of an operation and exactly one address. The instruction code of a single-address computer may include both zero- and multi-address instructions as special cases.

INSTRUCTION, ONE-PLUS-ONE or THREE-PLUS-ONE ADDRESS

a two- or four-address instruction, respectively, in which one of the addresses always specifies the location of the next instruction to be performed.

INSTRUCTION, TRANSFER

a computer operational step in which a signal or set of signals specifies the location of the next operation to be performed and directs the computer to that operation (or instruction).

INSTRUCTION, TWO, THREE or FOUR ADDRESS

an instruction consisting of an operation and 2, 3, or 4 addresses, respectively. The addresses may specify the location of operands, destination of results, or location of other or next instruction.

INSTRUCTION, ZERO-ADDRESS

an instruction specifying an operation in which the location of the operands are defined by the computer code, so that no address need be given explicitly.

INTEGRATOR

a device whose output is proportional to the integral with respect to the input variable.

INTERLACE

to assign successive storage locations to physically separated storage positions, e.g. on a magnetic drum or tape, usually for the express purpose of reducing access time.

ITEM

a set of one or more fields containing related information; a unit of correlated information relating to a single person or object; the contents of a single message.

INTERPRETER

an interpretive routine.

JUMP

an instruction or signal which, conditionally or unconditionally, specifies the location of the next instruction and directs the computer to that instruction. A jump is used to alter the normal sequence control of the computer. Under certain special conditions, a jump may be forced by manual intervention. In other words a transfer of control is made to a specified instruction.

JUMP, CONDITIONAL

an instruction which will cause the proper one of two (or more) addresses to be used in obtaining the next instruction, depending upon some property of one or more numerical expressions or other conditions.

KEY

a group of characters usually forming a field, utilized in the identification or location of an item; a marked lever manually operated for copying a character, e.g. typewriter, paper tape perforator, card punch manual keyboard, digitizer or manual word generator.

LAG

a relative measure of the time delay between two events, states, or mechanisms.

LANGUAGE, MACHINE

expressions which define the operations of a computer, usually intelligible to the computer by means of its circuitry. It may be information recorded in a form which may be made available to a computer; coded information which can be sensed by a machine.

LATENCY

in a serial storage system, the access time less the word time, e.g. the time spent waiting for the desired word or unit of information to appear under the drum heads or at the end of an acoustic tank.

LIBRARY, ROUTINE

an ordered set or collection of standard and proven routines and subroutines by which problems and parts of problems may be solved, usually stored in relative or symbolic coding. (A library may be subdivided into various volumes, such as floating decimal, double-precision, or complex, according to the type of arithmetic employed by the subroutines.)

LINE, DELAY

a device capable of causing an energy impulse to be retarded in time from point to point, thus providing a means of storage by circulating intelligence bearing-pulse configurations and patterns. Examples of delay lines are material media such as mercury, in which sonic patterns may be propagated in time; lumped constant electrical lines; co-axial cables, transmission lines and recirculating magnetic drum loops.

LINE-PRINTING

printing an entire line of characters across a page as the paper feeds in one direction past a type bar or cylinder bearing all characters on a single element.

LINE TRANSMISSION

any conductor or systems of conductors used to carry electrical energy from its source to a load.

LOCATION

a unit storage position in the main internal storage, storing one computer word; a storage register.

LOCATION, STORAGE

a storage position holding one computer word, usually designated by a specific address or a specific register.

LOGGER

a device which automatically records physical processes and events, usually chronologically.

LOGIC

the science that deals with the canons and criteria of validity in thought and demonstration; the science of the formal principles of reasoning; the basic principles and applications of truth tables, gating, interconnection, etc. required for arithmetic computation in a computer.

LOGIC, SYMBOLIC

exact reasoning about relations using symbols that are efficient in calculation. A branch of this subject known as Boolean algebra has been of considerable assistance in the logical design of computing circuits.

LOGICAL

see Operation, Logical.

LOOP

the repetition of a group of instructions in a routine.

LOOP, CLOSED

repetition of a group of instructions which may be repeated indefinitely.

MALFUNCTION

a failure in the operation of the hardware of a computer. See Error.

MATRIX

in mathematics, an array of quantities in a prescribed form, usually capable of being subject to a mathematical operation by means of an operator or another matrix according to orescribed rules; an array of circuit elements, e.g. diodes, wires, magnetic cores, relays, etc. which are capable of performing a specific function, e.g. conversion from one numerical system to another or selection of a channel based upon the input signal pattern.

MEMORY

the term "storage" is preferred.

MERGE

to produce a single sequence of items, ordered according to some rule (i.e., arranged in some orderly sequence), from two or more sequences previously ordered according to the same rule, without changing the items in size, structure, or total number. Merging is a special case of collation.

MESSAGE

a group of words, variable in length, transported as a unit; a transported item of information.

MICROSECOND

a millionth part of a second. Abbreviated usec.

MILLISECOND

a thousandth part of a second. Abbreviated msec.

MISTAKE

a human blunder which results in an incorrect instruction in a program or in coding, an incorrect element of information, or an incorrect manual operation. See Error.

MNEMONIC

assisting, or intended to assist, memory; of or pertaining to memory; mnemonics is the art of improving the efficiency of the memory (in computers, storage).

MODIFIER

a quantity used to alter the address of an operand, e.g. the cycle index.

MODIFY

in an instruction, to alter the address of the operand; to alter a subroutine according to a defined parameter.

MULTIVIBRATOR

a type of relaxation oscillator used for the generation of non-sinusoidal waves in which the output of each of its two tubes is coupled to the input of the other to sustain oscillations.

MULTIVIBRATOR, ASTABLE

a free running type of relaxation oscillator used for the generation of non-sinusoidal waves.

MULTIVIBRATOR, MONOSTABLE

a type of relaxation oscillator used to sustain a trigger pulse for a specified time. The device assumes another state for a specified length of time at the end of which it returns to its original state, after being pulsed or forced into another state.

NORMALIZE

to adjust the exponent and mantissa of a floating-point result so that the mantissa lies in the prescribed standard (normal) range; standardize.

NOTATION

see "NUMBER-SYSTEM".

NOTATION, BIQUINARY

one of any number of mixed-base notations in which the term n^i in the definition of number system is replaced by the product $\prod_{j=0}^{i-1} m_j$. In the biquinary system, m_j is two for j odd, five for j even; a scale of notation wherein the base is alternately 2 and 5, e.g. the decimal number 3671 is biquinary 03 11 12 01, the first of each pair of digits counting 0 or 1 units of five and the second counts 0, 1, 2, 3 or 4 units. For comparison, the same number in Roman numerals is MMMDCLXXI. Biquinary notation expresses the representation of numbers by the abacus, and by the two hands and five fingers of man and is used in some computers.

NOTATION, CODED-DECIMAL

decimal notation in which the individual decimal digits are represented by some code.

NOTATION, MIXED-BASE

a number system in which the term n^i in the definition of number-system is replaced by the product $\prod_{j=0}^{i-1} m_j$, e.g. in the biquinary system m_j is two for j odd and five for j even.

NOTATION, POSITIONAL

in a number system, a notation in which the position of each digit determines the exponent to which the base is raised, the digit being the coefficient of the power of the base and the position of the digit indicating the power to which the base is raised, e.g. in decimal, positional notation, 264 is $2 \times 10^2 + 6 \times 10^1 + 4 \times 10^0$.

NUMBER, BINARY

a numerical value written in the base-two system of notation. Usually the characters 0 and 1 are used to express numbers, although any pair of arbitrary symbols could be used.

NUMBER, OPERATION

a number indicating the position of an operation or its equivalent subroutine in the sequence forming a problem routine. When a problem is stated in pseudo-code, each step is sometimes assigned an operation number.

NUMBER, RANDOM

a set of digits constructed of such a sequence that each successive digit is equally likely to be any of n digits to the base n of the number.

NUMBER-SYSTEM

numerical notation; positional notation; a systematic method for representing numerical quantities in which any quantity is represented approximately by the factors needed to equate it to a sum of multiples of powers of some chosen base n. That is, a number x

$= a_q n^q + a_{q-1} n^{q-1} + \ldots + a_1 n + a_o + a_{-1} n^{-1} + \ldots + a_{-p} n^{-p}$

$= \sum_{i=p}^{i=q} a_i n^i$, with $n < a_i \leqslant 0$ for all i, is represented by $a_q a_{q-1} \ldots a_1 a_o a_{-1} \ldots a_{-p}$, with a point to the right of a_o to identify it. For example, in decimal notation familiar to all, in which n equals ten, x = 371.426 represents $3 \cdot 10^2 + 7 \cdot 10^1 + 1 \cdot 10^0 + 4 \cdot 10^{-1} + 2 \cdot 10^{-2} + 6 \cdot 10^{-3}$; in binary notation, in which n equals two, x = 1101.01 represents $1 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 + 0 \cdot 2^{-1} + 1 \cdot 2^{-2}$, which = 13.75 in decimal notation. In writing numbers, the base is sometimes indicated as a subscript (itself always in decimal notation) whenever there is any doubt about what base is being employed (e.g., $1101.11_2 = 13.75_{10}$); Binary, Ternary, Quatenary, Quinary, Octal (Octonary), Decimal, Duodecimal, Sexadecimal (Hexadecimal) or Duotricenary Notation - notation using the base 2, 3, 4, 5, 8, 10, 12, 16 or 32 respectively.

OCTAL

pertaining to the number base of eight, e.g. in octal notation, octal 214 is 2 times 64 plus 1 times 8 plus 4 times 1 equals decimal 140; octal 214 is binary-coded-octal 010, 001, 100; octal 214 is straight binary 10001100.

ONE-ADDRESS

single address; a system of machine instruction such that each complete instruction explicitly describes one operation and one storage location. See Instruction, One-Address.

ON-LINE OPERATION

a type of system application in which the input data to the system is fed directly from the measuring devices and the computer results obtained during the progress of the event, e.g. a computer receives data from wind tunnel measurements during a run, and the computations of dependent variables are performed during the run enabling a change in the conditions so as to produce particularly desirable results.

OPERAND

any one of the quantities entering or arising in an operation. An operand may be an argument, a result, a parameter, or an indication of the location of the next instruction; generally, the quantity being operated upon.

OPERATION

a defined action; the action specified by a single computer instruction or pseudo-instruction; an arithmetical, logical, or transferal unit of a problem, usually executed under the direction of a subroutine.

OPERATION, ARITHMETICAL

an operation in which numerical quantities form the elements of the calculation (e.g., addition, subtraction, multiplication, division).

OPERATION, AVERAGE-CALCULATING

a common or typical calculating operation longer than an addition and shorter than a multiplication; often taken as the average of nine addition and one multiplication time.

OPERATION, COMPLETE

an operation which includes (a) obtaining the instruction, (b) obtaining all operands from storage, (c) performing the operation, and (d) returning results to storage.

OPERATION, COMPUTER

the electronic action resulting from an instruction; in general, computer manipulation required to secure computed results.

OPERATION, FIXED-CYCLE

a type of computer performance whereby a fixed amount of time is allocated to an operation; synchronous or clock-type arrangement within a computer in which events occur as a function of measured time.

OPERATION, LOGICAL

an operation in which logical (yes-or-no) quantities form the elements being operated on (e.g., comparison, extraction). A usual requirement is that the value appearing in a given column of the result shall not depend on the values appearing in more than one given column of each of the arguments.

OPERATION, REAL-TIME or ON-LINE

the processing of data in synchronism or in coincidence with a physical process in such a fashion that the results of the data-processing are useful to the physical operation.

OPERATION, RED-TAPE

an operation which does not directly contribute to the result; i.e., arithmetical, logical, and transfer operations used in modifying the address section of other instructions in counting cycles, in rearranging data, etc.

OPERATION, SERIAL

the flow of information through a computer in time sequence, using only one digit, word, line or channel at a time. Contrasted with parallel operation.

OPERATION, TRANSFER

an operation which moves information from one storage location or one storage medium to another (e.g., read, record, copy, transmit, exchange). Transfer is sometimes taken to refer specifically to movement between different media; storage to movement within the same medium.

OPERATION, VARIABLE-CYCLE

computer action in which any cycle of action or operation may be of different lengths. This kind of action takes place in an asynchronous computer.

OPERATOR

the person who actually manipulates the computer controls, places information media into the input devices, removes the output, presses the start button, etc.; a mathematical symbol which represents a mathematical process to be performed on an associated function; generally, the quantity which indicates an operation to be performed upon an operand e.g. d/dt, ∇, $\int dt$, etc.).

OR-CIRCUIT

an electrical or mechanical device which will yield an output signal whenever there are one or more inputs on a multichannel input, e.g. an OR gate is one in which a pulse output occurs whenever one or more inputs are pulsed; forward merging of pulses simultaneously providing reverse isolation. See Inclusive-OR and Exclusive-OR.

ORDER

a defined successive arrangement of elements or events. The word order is losing favor as a synonym for instruction, command or operation part sue to ambiquity.

OR-OPERATOR

a logical operator which has the property such that if P or Q are tow statements, then the statement "P OR Q" is true or false precisely according to the following table of possible combinations: (See Inclusive and Exclusive OR)

P		Q		P or Q	
False	0	True	1	True	1
True	1	False	0	True	1
True	1	True	1	True	1
False	0	False	0	False	0

The term disjunction is applied to this operator.

OSCILLATIONS, FREE

oscillating currents or voltages which continue to flow in a tuned circuit after the impressed voltage has been removed. Their frequency is the resonant frequency of the circuit. They are due to interchange electromagnetic and electrostatic energy and the fact that a time rate of change of charge is an electric current which stores energy in the form of a magnetic field and a time rate of change of magnetic field produces a voltage which stores energy in the form of an electric field. The energies of these two fields interchange.

OUTPUT

information transferred from the internal storage of a computer to secondary or external storage; information transferred to any device exterior to the computer.

OUTPUT-BLOCK

a portion of the internal storage reserved primarily for receiving, processing and transmitting data which is to be transferred out.

OVERFLOW

in an arithmetic operation, the generation of a quantity beyond the capacity of the register or location which is to receive the result; over capacity; the information contained in an item of information which is in excess of a given amount.

PACK

to include several brief or minor items of information into one machine item or word by utilizing different sets of digits for the specification of each brief or minor item.

PARALLEL

handled simultaneously in separate facilities; operating on two or more parts of a word or item simultaneously; contrasted with serial.

PARAMETER

in a subroutine, a quantity which may be given different values when the subroutine is used in different main routines or in different parts of one main routine, but which usually remains unchanged throughout any one such use; in a generator, a quantity used to specify input-output devices, to designate subroutines to be included, or otherwise to describe the desired routine to be generated; in mathematics, a variable which can be held constant temporarily, usually giving rise to a family of curves.

PARAMETER, PRESET

a parameter incorporated into a subroutine during input.

PARAMETER, PROGRAM

a parameter incorporated into a subroutine during computation. A program parameter frequently comprises a word stored relative to either the subroutine or the entry point and dealt with by the subroutine during each reference. It may be altered by the routine and/or may vary from one point of entry to another.

PATCH

section of coding inserted into a routine to correct a mistake or alter the routine; explicitly transferring control from a routine to a section of coding and back again.

PENTODE

a five-electrode vacuum tube containing a cathode, control grid, screen grid, suppressor grid, and plate. The grids may be referred to as grids no. 1, 2, and 3, respectively.

PERFORATION, RATE of

number of characters, rows or words punched in a paper tape by a device per unit of time.

PHOSPHORESCENCE

the property of emitting light for some time after excitation.

PIEZOELECTRIC

the effect of producing a voltage by placing a stress variation, either by compression, by expansion, or by twisting, on a material, usually certain crystals and, conversely, the effect of producing a stress in a crystal by applying a voltage to it.

PLOTTING-BOARD

a device capable of graphically presenting information, usually as curves of one or more variables; analogue curve or point tracer.

PLUG-BOARD

a removable panel containing an ordered array of terminals which may be interconnected by short electrical leads according to a prescribed pattern and hence designating a specific program or machine step. The entire panel, pre-wired, may be inserted for different programs. Used to a large extent in CPC's, printers, tabulators, summary punches and some computers e.g. the Univac File Computer.

POINT

the dot that marks the separation between the integral and fractional parts of a quantity; i.e., between the coefficients of the zero and the minus one powers of the number base. It is usually called, for a number system using base two, a <u>binary point</u>; for base ten, a <u>decimal point</u>, etc; base point; radix.

POST MORTEM

a routine which, either automatically or on demand, prints information concerning the contents of the registers and storage locations at the time the routine stopped, in rder to assist in the location of a mistake in coding.

POTENTIOMETER

a variable voltage divider, a resistor which has a variable contact arm so that any portion of the potential applied between its ends may be selected.

PRECISION

the degree of exactness with which a quantity is stated; a relative term often based on the number of significant digits in a measurement. See also Accuracy.

PRECISION, DOUBLE

retention of twice as many digits of a quantity as the computer normally handles, e.g. a computer whose basic word consists of 10 decimal digits is called upon to handle 20 decimal digit quantities.

PRE-STORE

to set an initial value for the address of an operand or a cycle index; to restore; to store a quantity in an available or convenient location before it is required in a routine.

PROGRAM

a plan for the solution of a problem. A complete program includes plans for the transcription of data, coding for the computer and plans for the absorption of the results into the system. The list of coded instructions is called a routine; to plan a computation or process from the asking of a question to the delivery of the results, including the integration of the operation into an existing system. Thus programming consists of planning and coding, including numerical analysis, systems analysis, specification of printing formats, and any other functions necessary to the integration of a computer in a system.

PROGRAM, ASSEMBLY

a program designed to place various sections of another program in their programmer designated locations. Some assembly programs also contain the elements of a translator or translation program.

PROGRAM SENSITIVE MALFUNCTION

a malfunction which occurs only when some unusual combination of program steps occur.

PROGRAMMER

a person who prepares instruction sequences without necessarily converting them into the detailed codes of a particular computer.

PROGRAMMING AUTOMATIC

any technique in which the computer is used to help plan as well as to help code a problem; e.g. compiling routines, interpretive routines.

PROGRAMMING, OPTIMUM

improper terminology for minimal latency coding, i.e., for producing a minimal latency routine; programming in order to make efficient use of hardware e.g. least storage usage, time share of peripheral equipment, use of time between operations, etc.

PROGRAMMING, RANDOM-ACCESS

programming without regard for the time required for access to the storage positions called for in the program; contrast with minimum access programming or minimal latency programming.

PSEUDO-CODE

an arbitrary code, independent of the hardware of a computer, which must be translated into computer code.

PSEUDO-RANDOM

having the property of satisfying one or more of the standard criteria for statistical randomness but being produced by a definite calculation process.

PULSE

a change in the intensity or level of some medium, usually over a relatively short period of time, e.g. a shift in electric potential of a point for a short period of time compared to the time period, i.e., if the voltage level of a point shifts from -10 to +20 volts with respect to ground for a period of 2 microseconds, one says that the point received a 30 volt 2 microsecond pulse.

PULSE-CODE

sets of pulses to which particular meanings have been assigned; the binary representations of characters.

PUNCH, CALCULATING, ELECTRONIC

a card handling machine which reads a punched card, performs a number of sequential operations and punches the result on a card.

PUNCH, CARD

a device which perforates or places holes in cards in specific locations designated by a program.

PUNCH-POSITION

the location of the row in a columniated card e.g. in an 80-column card the rows or "punch position" may be 0 to 9 and "X" and "Y" corresponding to position 11 and 12.

PUNCH, SUMMARY

a card handling machine which may be electrically connected to another machine, e.g. tabulator and which will punch out on a card the information produced, calculated or summarized by the other machine.

PUNCHING, RATE of

number of cards, characters, blocks, fields or words of information placed in the form of holes distribution on cards, or tape per unit of time.

QUANTITY

a positive or negative real number in the mathematical sense. The term quantity is preferred to the term number in referring to numerical data; the term number is used in the sense of natural number and reserved for "the number of digits", the "number of operations", etc.

QUANTITY, DOUBLE-PRECISION

a quantity having twice as many digits as are normally carried in a specific computer.

RANDOM-ACCESS

access to storage under conditions in which the next position from which information is to be obtained is in no way dependent on the previous one.

RANGE

all the values which a function may have; the difference between the limits imposed upon a variable.

RATIO, OPERATING

the ratio obtained by dividing the number of hours of correct machine operation by the total hours of scheduled operation, e.g. on a 168 hour week scheduled operation, if 12 hours of preventive maintenance is required and 4.8 hours of unscheduled down time occurs, then the operating ratio is (168 - 16.8)/168, which is equivalent to a 90% operating ratio.

READ

to copy, usually from one form of storage to another, particularly from external or secondary storage to internal storage; to sense the meaning or arrangements of hardware; to sense the presence of information on a recording medium.

READ-AROUND-RATIO

in electrostatic storage tubes, the number of times a specific spot (digit or location) may be consulted before "spill over" will cause a loss of information stored in surrounding spots, immediately prior to which the surrounding information must be restored; read-around number.

READER, CARD

a mechanism that permits the sensing of information punched on cards by means of wire brushes, metal feelers, or a photoelectric device, converting the information into electrical pulses that are sensible to the computing system.

READER, TAPE, MAGENTIC

a device capable of restoring to a train or sequence of electrical pulses, information recorded on a magnetic tape in the form of a series of magnetized spots, usually for the purpose of transferring the information to some other storage medium.

READER, TAPE, PAPER

a device capable of restoring to a train or sequence of electrical pulses, information punched on a paper tape in the form of a series of holes, usually for the purpose of transferring the information to some other storage medium.

READING, RATE of

number of characters, words, fields, blocks or cards sensed by an input sensing device per unit of time.

REAL-TIME

the performance of a computation during the actual time that the related physical process transpires in order that results of the computations are useful in guiding the physical process.

RECORD

a listing of information, usually in printed or printable form; one output of a compiler consisting of a list of the operations and their positions in the final specific routine and containing information describing the segmentation and storage allocation of the routine; to copy or set down information in reusable form for future reference; to make a transcription of data by a systematic alteration of the condition, property or configuration of a physical medium, e.g., placing information on magnetic tape or a drum by means of magnetized spots.

REGENERATION

the process of returning a part of the output signal of an amplifier to its input circuit in such a manner that it reinforces the grid excitation and thereby increases the total amplification; periodic restoration of stored information.

REGISTER

the hardware for storing one or more computer words. Registers are usually nearby zero-access storage devices.

REGISTER, CIRCULATING or MEMORY

a register (or memory) consisting of a means for delaying information and a means for regenerating and reinserting the information into the delaying means.

REGISTER, CONTROL

the accumulator, register or storage unit which stores the current instruction governing a computer operation; an instruction register.

REGISTER, PROGRAM

a register in the control unit which stores the current instruction of the program and controls computer operation during the execution of the instruction; control register; program counter.

REGULATION, VOLTAGE

a measure of the degree to which an electrical power source maintains its output-voltage stability under varying load conditions.

REPETITION, RATE of PULSE

the number of electric pulses per unit of time experienced by a point in a computer, usually the maximum, normal, or standard rate of pulses.

REPRESENTATIVE-CALCULATING-TIME

a method of evaluating the speed performance of a computer. One method is to use one-tenth of the time required to perform nine complete additions and one complete multiplication. A complete addition or a complete multiplication time includes the time required to procure two operands from high speed storage, perform the operation, and store the result and the time required to select and execute the required number of instructions to do this.

RERUN

to repeat all or part of a program on a computer.

RERUN-POINT

that stage of a computer run at which all information pertinent to the running of the routine is available either to the routine itself or to a rerun routine in order that a run may be reconstituted.

RESET

to return a device to zero or to an initial or arbitrarily selected condition.

RESOLVER

a device which separates or breaks up a quantity, particularly a vector, into constituent parts or elements, e.g. to form the three mutually-perpendicular components of a space vector.

RESPONSE, FREQUENCY

a measure of the ability of a device to take into account, follow or act upon a rapidly varying condition, e.g. as applied to amplifiers, the frequency at which the gain has fallen to the one-half power point or to 0.707 of the voltage gain factor; as applied to a mechanical controller, the maximum rate at which changes in condition can be followed and acted upon.

RESTORE

to return a cycle index, a variable address, or other computer word to its initial or preselected value; periodic regeneration of charge, especially in volatile, condenser-action storage systems; when sensing the contents of a storage location destructively, to return the contents or regenerate the contents after reading.

RETURN

to go back to a specific, planned point in a program, usually when an error is detected, for the purpose of rerunning the program. Rerun points are usually three to five minutes apart to avoid long periods of lost computer time. Information pertinent to a rerun is available in standby registers from point to point.

REWIND

to return a film or magnetic tape to its beginning or passed location.

ROLLBACK

equivalent to rerun when referring to tape-sequenced computers; to recapture tape-inscribed data.

ROLL-OUT

to read a register or counter by adding ones to the respective digits simultaneously obtaining a signal as each column returns to zero, until all columns have returned to zero, usually requiring n additions, where n is the number base.

ROUND-OFF

to change a more precise quantity to a less precise one, according to some rule, usually in order to keep the number of digits expressing the number.

ROUTINE

a set of coded instructions arranged in proper sequence to direct the computer to perform a desired operation or series of operations.

ROUTINE, COMPILING

an executive routine which, before the desired computation is started, translates a program expressed in pseudo-code into machine code (or into another pseudo-code for further translation by an interpreter). In accomplishing the translation, the compiler is required to decode, convert, select, generate, allocate, adapt, orient, incorporate, or record.

ROUTINE, DIAGNOSTIC

a specific routine designed to locate either a malfunction in the computer or a mistake in coding.

ROUTINE, EXECUTIVE

a set of coded instructions designed to process and control other sets of coded instructions; a set of coded instructions used in realizing "automatic coding"; a master set of coded instructions.

ROUTINE, FLOATING-POINT

a set of coded instructions arranged in proper sequence to direct the computer to perform a specific set of operations which will permit floating-point operation, e.g. enable the use of a fixed-point machine to handle information on a floating-point basis from an external point of view. Floating-point routines are usually used in computers which do not have built in floating-point circuitry, in which case floating-point operation must be programmed.

ROUTINE, GENERAL

a routine expressed in computer coding designed to solve a class of problems, specializing to a specific problem when appropriate parametric values are supplied.

ROUTINE, INTERPRETIVE

an executive routine which, as the computation progresses, translates a stored program expressed in some machine-like pseudo-code into machine code and performs the indicated operations, by means of subroutines as they are translated. An interpretive routine is essentially a closed subroutine which operates successively on an indefinitely-long sequence of program parameters (the pseudo-instructions and operands). It may usually be entered as a closed subroutine and exitted by a pseudo-code exit instruction.

ROUTINE, MINIMAL LATENCY

especially in reference to serial storage systems, a routine so coded, by judicious arrangement of data and instructions in storage, that the actual latency is appreciably less than the expected random-access latency.

ROUTINE, RERUN

a routine designed to be used in the wake of a computer malfunction or a coding or operating mistake to reconstitute a routine from the last previous rerun point; roll back routine. See Rerun.

ROUTINE, SEQUENCE-CHECKING

a routine which checks every instruction executed, printing certain data, e.g., to print out the coded instruction with addresses, and the contents of each of several registers, or it may be designed to print out only selected data, such as transfer instructions and the quantity actually transferred.

ROUTINE, SERVICE

a routine designed to assist in the actual operation of the computer. Tape comparison, block location, certain post mortems, and correction routines fall in this class.

ROUTINE, SPECIFIC

a routine expressed in computer coding designed to solve a particular mathematical, logical, or data-handling problem in which each address refers to explicitly stated registers and locations.

ROUTINE, TEST

a routine designed to show whether a computer is functioning properly or not.

RUN

one performance of a program on a computer; performance of one routine, or several routines automatically linked so that they form an operating unit, during which manual manipulations are not required of the computer operator.

SCALE

to alter the units in which all variables are expressed so as to bring all magnitudes within the capacity of the computer or routine at hand.

SCANNER

an instrument which automatically samples or interrogates the state of various processes, conditions, or physical states and initiates action in accordance with the information obtained.

SEGMENT

to divide a routine in parts each consisting of an integral number of subroutines, each part capable of being completely stored in the internal storage and containing the necessary instructions to jump to other segments; in a routine too long to fit into internal storage, a part short enough to be stored entirely in the internal storage and containing the coding necessary to call in and jump automatically to other segments. Routines which exceed internal storage capacity may be automatically divided into segments by a compiler.

SELECT

to take the alternative A if the report on a condition is of one state, and alternative B if the report on the condition is of another state; to choose a needed subroutine from a file of subroutines.

SELECTOR

a device which interrogates a condition and initiates a particular operation according to the interrogation report.

SENSE

to examine, particularly relative to a criterion; to determine the present arrangement of some element of hardware, especially a manually-set switch; to read holes punched in paper.

SENTINEL

a symbol marking the beginning or the end of some element of information such as a field, item, block, tape, etc; a tag.

SEQUENCE, PSEUDO-RANDOM

an order of numbers produced by a definite recursive rule but satisfying one or more of the standard tests for randomness.

SEQUENCER

a machine which puts items of information into a particular order, e.g., it will determine whether A is greater than, equal to, or less than B, and sort or order accordingly.

SERIAL

handle one after the other in a single facility, such as transfer or store in a digit by digit time sequence.

SERVOMECHANISM

a closed loop system in which the error or deviation from a desired or pre-set norm is reduced to zero, and one in which mechanical position is usually the controlled variable, e.g., a synchronized drum storage system requires a servomechanism to insure synchronism between a crystal controlled electronic oscillator and a rotating cylinder; an AA fire control gun-positioning system requires a servo to insure that deviations are corrected.

SHIFT

to move the characters of a unit of information column-wise right or left. For a number, this is equivalent to multiplying or dividing by a power of the base of notation.

SHIFT, ARITHMETIC

to multiply or divide a quantity by a power of the number base, e.g. binary 1011 represents decimal 11, therefore two arithmetic shifts to the left is binary 101100, which represents decimal 44; which means 11 was multiplied by two twice when a binary number is shifted. If the decimal 11 was shifted twice, it would mean multiplication by 100, or a result of 1100.

SHIFT, CYCLIC

a shift in which the digits dropped off at one end of a word are returned at the other in a circular fashion; logical, non-arithmetical or circular shift.

SIGNIFICANCE

the arbitrary rank, priority, or order of relative magnitude assigned to a given position or column in a number; the significant digits of a number are a set of digits, usually from consecutive columns beginning with the most significant digit different from zero and ending with the least significant digit whose value is known are assumed relevant, e.g., 2300.0 has five significant digits, whereas 2300 probably has two significant digits. However 2301 has four significant digits.

SIMULATION

the representation of physical systems and phenomenona by computers, models or other equipment.

SKIP

an instruction to proceed to the next instruction; a "blank" instruction.

SOLVER, EQUATION

a calculating device, usually analog, which arrives at the solution to systems of linear simultaneous non-differential equations or determine the roots of polynomials or both.

SORT

to arrange items of information according to rules dependent upon a key or field contained in the items.

STACKER, CARD

a mechanism that accumulates cards in a bin after they have passed through a machine operation.

STANDARDIZE

to adjust the exponent and mantissa of a floating-point result so that the mantissa lies in the prescribed normal range; normalize; see Floating-point Representation.

STORAGE

preferred to memory, any device into which units of information can be copies, which will hold this information, and from which the information can be obtained at a later time; devices, such as plugboards, which hold information in the form of arrangements of physical elements, hardware, or equipment; the erasable storage in any given computer.

STORAGE, BUFFER

a synchronizing element between two different forms of storage, usually between internal and external; an input device in which information is assembled from external or secondary storage and stored ready for transfer to internal storage; an output device into which information is copied from internal storage and held for transfer to secondary or external storage. Computation continues while transfers between buffer storage and secondary or internal storage or vice versa take place.

STORAGE, CIRCULATING

a device using a delay line, or unit which stores information in a train or pattern of pulses, where the pattern of pulses issuing at the final end are sensed, amplified, reshaped and re-inserted in the delay line at the beginning end. See Delay-Line.

STORAGE, DYNAMIC

storage such that information at a certain position is moving or varying with time and so is not always available instantly; e.g., acoustic delay line, magnetic drum; circulating or re-circulating of information in a medium.

STORAGE, ELECTROSTATIC

a device possessing the capability of storing changeable information in the form of charged or uncharged areas on the screen of a cathode ray tube.

STORAGE, ERASABLE

media which may hold information that can be changed; i.e., the media can be re-used; e.g., magnetic tape, drum, or core.

STORAGE, EXTERNAL

storage facilities divorced from the computer itself but holding information in the form prescribed for the computer; e.g., magnetic tapes, magnetic wire, punched cards, etc.

STORAGE, INTERNAL

storage facilities forming an integral physical part of the computer and directly controlled by the computer; the total storage automatically accessible to the computer.

STORAGE, MAGNETIC

any storage system which utilizes the magnetic properties of materials to store information.

STORAGE, MERCURY

columns of a liquid mercury medium used as a storage element by the delaying action or time of travel of sonic pulses which are circulated by having electrical amplifier, shaper, and timer circuits complete the loop.

STORAGE, NON-ERASABLE

media used for containing information which cannot be erased and reused, such as punched paper tapes, and punched cards.

STORAGE, NON-VOLATILE

storage media which retain information in the absence of power and which may be made available upon restoration of power; e.g., magnetic tapes, drums, or cores.

STORAGE, PARALLEL

storage in which all bits, or characters, or (especially) words are essentially equally available in space, without time being one of the coordinates. Parallel storage contrasts with serial storage. When words are in parallel, the storage is said to be parallel by words; when characters within words (or binary digits within words or characters) are dealt with simultaneously, not one after the other, the storage is parallel by characters (or parallel by bit respectively). Contrasted with Storage, Parallel.

STORAGE, SECONDARY

storage facilities not an integral part of the computer but directly connected to and controlled by the computer; e.g., magnetic drum, magnetic tapes, etc.

STORAGE, SERIAL

storage in which time is one of the coordinates used to locate any given bit, character, or (especially) word. Storage in which words, within given groups of several words, appear one after the other in time sequence, and in which access time therefore includes a variable latency or waiting time of from zero to many-times, is said to be serial by word. Storage in which the individual bits comprising a word appear in time sequence is serial by bit. Storage for coded-decimal or other non-binary numbers in which the characters appear in time sequence is serial by character; e.g., magnetic drums are usually serial by word but may be serial by bit, or parallel by bit, or serial by character and parallel by bit, etc.

STORAGE, STATIC

storage such that information is fixed in space and available at any time; e.g., flip-flop, electrostatic, or coincident-current magnetic-core storage.

STORAGE, TEMPORARY

internal storage locations reserved for intermediate and partial results.

STORAGE, VOLATILE

storage media such that if the applied power is cut off, the stored information is lost; e.g., acoustic delay lines, electrostatic tubes.

STORAGE, WORKING

a portion of the internal storage reserved for the data upon which operations are being performed.

STORAGE, ZERO-ACCESS

storage for which the latency (waiting time) is small at all times.

STORE

to transfer an element of information to a device from which the unaltered information can be obtained at a later time.

SUBROUTINE

the set of instructions necessary to direct the computer to carry out a well defined mathematical or logical operation; a subunit of a routine. A subroutine is often written in relative or symbolic coding even when the routine to which it belongs is not.

SUBROUTINE, CLOSED

a subroutine not stored in its proper place in the linear operational sequence, but stored away from the routine which refers to it. Such a subroutine is entered by a jump, and provision is made to return, i.e., to jump back to the proper point in the main routine at the end of the subroutine.

SUBROUTINE, DYNAMIC

a subroutine which involves parameters, such as decimal point position or item size, from which a relatively coded subroutine is derived. The computer itself is expected to adjust or generate the subroutine according to the parametric values chosen.

SUBROUTINE, OPEN

a subroutine inserted directly into the linear operational sequence, not entered by a jump. Such a subroutine must be recopied at each point that it is needed in a routine.

SUBROUTINE, STATIC

a subroutine which involves no parameters other than the addresses of the operands.

SUBSTITUTE

to replace an element of information by some other element of information.

SWITCH, ELECTRONIC

a circuit which causes a start-and-stop action or a switching action by electronic means.

SWITCH, FUNCTION

a circuit having a fixed number of inputs and outputs designed such that the output information is a function of the input information, each expressed in a certain code or signal configuration or pattern.

SYMBOL, LOGICAL

a symbol used to represent a logical element graphically.

SYSTEM

an assembly of components united by some form of regulated interaction; an organized whole.

TABULATOR

a machine which reads information from one medium, e.g., cards, paper tape, magnetic tape, etc. and produces lists, tables, and totals on separate forms or continuous paper.

TAG

a unit of information, whose composition differs from that of other members of the set so that it can be used as a marker or label; a sentinel.

TANK

a unit of acoustic delay line storage, containing a set of channels each forming a separate recirculation path; a circuit consisting of inductance and capacitance used for the purpose of sustaining electrical oscillations.

TAPE, MAGNETIC

a tape or ribbon of any material impregnated or coated with magnetic material on which information may be placed in the form of magnetically polarized spots.

TAPE, PROGRAM

a tape which contains the sequence of instructions required for solving a problem and which may be read by the computer.

TERNARY

pertaining to the system of notation utilizing the base of 3, employing the characters 0, 1, and 2.

TEST, CRIPPLED-LEAP-FROG

a variation of the leap-frog test, modified so that it repeats its tests from a single set of storage locations rather than a changing set of locations.

TEST, LEAPFROG

a program designed to discover computer malfunction, characterized by the property that it performs a series of arithmetical or logical operations on one group of storage locations, transfers itself to another group of storage locations, checks the correctness of the transfer, then begins the series of operations over again. Eventually, all storage positions will have been occupied and the test will be repeated.

TETRAD

a group of four, usually four pulses, in particular, a group of four pulses used to express a decimal digit, or a sexadecimal digit by means of four (binary) pulses.

TETRODE

a four-electrode vacuum tube containing a cathode, control grid, screen grid, and plate.

THERMISTOR

the thermistor is a solid state, semiconducting device made by sintering mixtures of the oxide powders of various metals. It is made in many shapes, such as beads, disks, flakes, washers, and rods, to which contact wires are attached. As its temperature is changed, the electrical resistance of the thermistor varies. The associated temperature coefficient of resistance is extremely high, nonlinear, and negative.

THERMOCOUPLE

a device made up of two bi-metal joints (usually wires forming a closed loop) having the property that if the two junctions are maintained at different temperatures, a difference of potential is brought into existence equally distributed between the two junctions.

THREE-ADDRESS

see Code, Multiple-address.

THYRATRON

a hot-cathode, gas-discharge tube in which one or more electrodes are used to control electrostatically the starting of an unidirectional flow of current.

TIME, CODE CHECKING

all time spent checking out a problem on the machine making sure that the problem is set up correctly, and that the code is correct.

TIME, ENGINEERING or SERVICING

all machine down time necessary for routine testing (good or bad), for machine servicing due to breakdowns, or for preventive servicing measures, e.g., block tube changes. Includes all test time (good or bad) following breakdown and subsequent repair or preventive servicing.

TIME, IDLE

time in which machine is believed to be in good operating condition and attended by service engineers but not in use on problems. To verify that the machine is in good operating condition, nachine tests of the leapfrog variety may be run.

TIME, NO CHARGE MACHINE-FAULT

unproductive time due to a computer fault such as the following: (1) non-duplication, (2) transcribing error, (3) input-output malfunction, (4) machine malfunction resulting in an incomplete run.

TIME, NO CHARGE NON-NACHINE-FAULT

unproductive time due to no fault of the computer such as the following: (1) good duplication, (2) error in preparation of input data, (3) error in arranging the program deck, (4) error in operating instructions or misinterpretation of instructions, (5) unscheduled good testing time, run during normal production period when machine malfunction is suspected but is demonstrated not to exist.

TIME, PRODUCTION

good computing time, including occasional duplication of one case for a check or rerunning of the test run. Also, duplication requested by the sponsor; any reruns caused by misinformation or bad data supplied by sponsor. Error studies using different intervals, convergence criteria, etc.

TIME, STANDBY UNATTENDED

time in which the machine is in an unknown condition and not in use of problems. Includes time in which machine is known to be defective and work is not being done to restore it to operating condition. Includes breakdowns which render it unavailable due to outside conditions (power outages, etc.).

TIME, SYSTEM, IMPROVEMENT

all machine down time needed for the installation and testing of new components, large or small, and machine down time necessary for modification of existing components. Includes all programmed tests following the above actions to prove machine is operating properly.

TRACK

in a serial magnetic storage element, a single path containing a set of pulses.

TRANSCRIBE

to copy, with or without translating, from one external storage medium to another.

TRANSDUCER

a device which converts energy from one form to another, e.g., a quartz crystal imbedded in mercury can change electrical energy to sound energy as is done in sonic delay lines in computer storage systems.

TRANSFER

to copy, exchange, read, record, store, transmit, transport, or write data; to change control; to jump to another location.

TRANSFER, CONDITIONALLY

to copy, exchange, read, record, store, transmit, or write data or to change control or jump to another location according to a certain specified rule or in accordance with a certain criterion.

TRANSFER, PARALLEL

a system of data transfer in which the characters of an element of information are transferred simultaneously over a set of paths.

TRANSFER, SERIAL

a system of data transfer in which the characters of an element of information are transferred in sequence over a single path in consecutive time positions.

TRANSFER, UNCONDITIONAL

an instruction which causes the subsequent instruction to be taken from an address which is not the next one in the sequence in a digital computer which ordinarily obtains its instructions serially from an ordered sequence at all other times.

TRANSFORM

to change informat[illegible] n fr[illegible] ti[illegible]n without altering [illegible] normalize, e[illegible]t, or su[illegible]

TRANSIENT

a phenome[illegible]on experiencing [illegible] o[illegible] time; som[illegible]thing which is t[illegible] or breakdown in the intensity [illegible] a [illegible]teady sta[illegible]e condition is r[illegible] phenomenon; [illegible]he time rate [illegible] f[illegible]ite and s[illegible]me form of energy [illegible] involved.

TRANSISTOR

an electronic device util[illegible] properties [illegible] control the fl[illegible] one source [illegible] one circuit by [illegible] circuit, e.g. a [illegible] transi[illegible] control of current in one [illegible] smaller current in another [illegible] transistor common to both ci[illegible]

TRANSLATE

to change inforamtion (e.g. [illegible] pseudo-code, data, or codi[illegible] to another without significant [illegible] meaning.

TRANSMIT

to reproduce information in [illegible] replacing whatever was previo[illegible] [illegible] or erasing the source of t[illegible]

TRANSPORT

to convey as a whole from [illegible] another.

TROUBLE-SHOOT

to search for a coding mis[illegible] computer malfunction in order [illegible]

TRUNCATE

to drop digits of a number [illegible] thus lessening precision, e[illegible] 3.14159265 is truncated to [illegible] whereas one may round off [illegible]

TRUNK

a path over which infor[illegible] a bus.

TUBE, ACORN

a small vacuum tube desig[illegible] frequency circuits. The tub[illegible] transit time and low interel[illegible]

TUBE, CATHODE-RAY

an electronic vacuum tube containing a screen on which information may be stored by means of a multigrid modulated beam of electrons from the thermionic emitter, storage effected by means of charged or uncharged spots; a storage tube; a Williams tube; an oscilloscope tube; a picture tube.

TUBE, WILLIAMS

a cathode ray tube used as an electrostatic storage device of the type designed by F. C. Williams, University of Manchester, England.

TWO-ADDRESS

see Code, multiple-address.

TYPEWRITER, ELECTRIC

a hand operated electric powered individual character printing device having the property that almost every operation of the machine after the keys are touched by human fingers is performed by electric power instead of manual power; a typewriter powered by electricity, in all other respects the same as a manually powered typewriter.

ULTRASONICS

the field of science devoted to frequencies of sound above the human audio range, i.e. above 20 kilocycles per second.

UNCONDITIONAL

not subject to conditions external to the specific instruction.

UNDERFLOW

the condition which arises when a machine computation yields a result which is smaller than the smallest possible quantity which the machine is capable of storing; in floating-point operations, when the exponent plus the excess becomes negative.

UNPACK

to decompose packed information into a sequence of separate words or elements.

UNWIND

to code explicitly, at length and in full all the operations of a cycle thus eliminating all red-tape operations in the final problem coding. Unwinding may be performed automatically by the computer during assembly, generation, or compilation.

VALIDITY

correctness; especially the degree of the closeness by which iterated results approach the correct result.

VARISTOR

a passive resistor-like circuit element whose resistance is a function of the current through it or voltage across its terminals, i.e. the current through it is a non-linear function of the voltage across its terminals, hence the linear form of Ohm's Law is not obeyed; a self-varying resistance.

VERIFIER

a device on which a manual transcription can be verified by comparing a retranscription with it character-by-character as it is being retranscribed.

VERIFY

to check a data transfer or transcription, especially those involving manual processes.

WIRE, MAGNETIC

wire made of a magnetic material along small incremental lengths of which magnetic dipoles are placed in accordance with binary information.

WORD

a set of characters which occupies one storage location and is treated by the computer circuits as a unit and transported as such. Ordinarily a word is treated by the control unit as an instruction, and by the arithmetic unit as a quantity. Word lengths are fixed or variable depending on the particular computer.

WORD, INFORMATION

an ordered set of characters bearing at least one meaning and handled by a computer as a unit, including separating spacing, which may be contrasted with instruction words.

WORD-TIME

especially in reference to words stored serially, the time required to transport one word from one storage device to another. See also Access Time.

WRITE

to transfer information to an output medium; to copy, usually from internal storage to external storage; to record information in a register, location, or other storage device or medium.

ZERO

nothing; positive binary zero is usually indicated by the absence of digits or pulses in a word; negative binary zero in a computer operating on one's complements by a pulse in every pulse position in a word; in a coded decimal machine, decimal zero and binary zero may not have the same representation. In most computers, there exist distinct and valid representation both for plus and for minus zero.